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A Power Plant to Make Power Plants

HOT WATER HEATING, WORKLESS STOKING, HEAT SAVING AND COMFORT IN A PLANT FOR MAKING AUTOMOBILE MOTORS

ANY PRODUCT MANUFACTURED over a long period of years and maintained at a high standard of excellence is sure to secure recognition as a leader in its class, especially if its merits are made widely known by judicious publicity. This may sound like the start of an article on advertising, but it is simply an explanation of the why of the growth in the business and plant of the J. I. Case Threshing Machine Co., which made necessary the power installation about to be described. Seventy years has made the Case name known wherever farm machinery is used, and the Eagle is a familiar emblem as a standard of high excellence in such machines. When, therefore, the Case Company entered the field of automobile manufacture, it carried, not only the same high standards of excellence and the same wisdom of method, but also the prestige which goes with such a record, and the response was a large demand for its machines, which, with the increase in other business, called for large facilities to make the motors and similar parts.

As a natural result, the South Works were planned and part of the buildings are completed, the rest in course of construction, and sufficient of the power plant has been installed to care for the present needs, with room for expansion as may be necessary. The power requirements were for light, heat and driving machinery under the following conditions; as the plant is on the

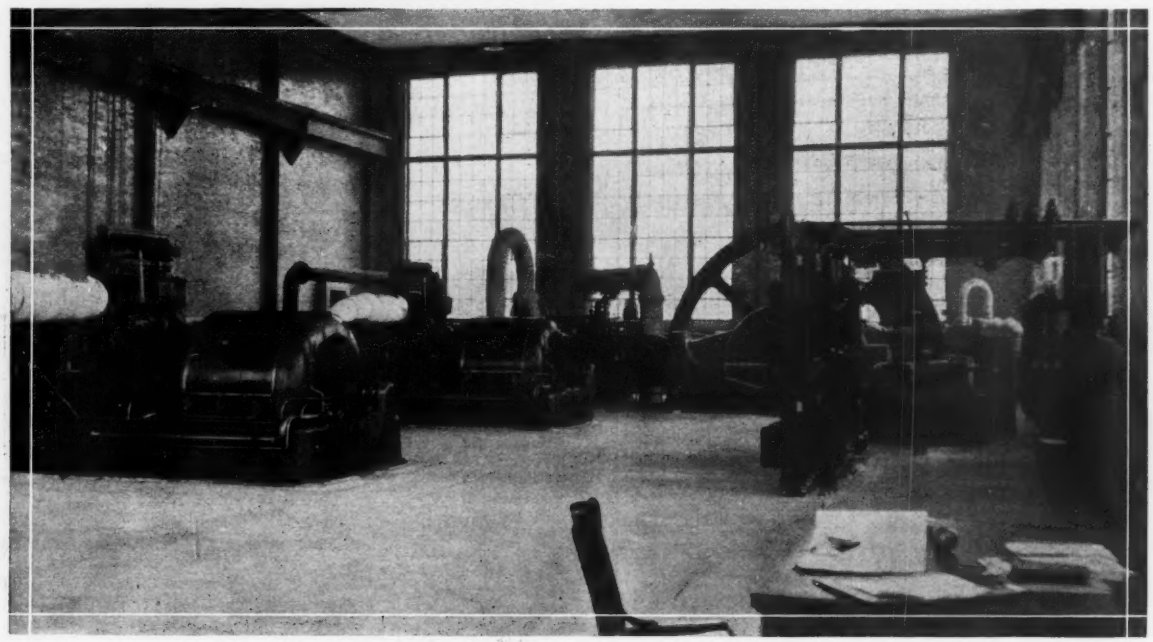


FIG. 1. GENERAL VIEW OF TURBINE ROOM

shore of Lake Michigan, plenty of cooling water is available for condensing, but the water is not well fitted at that point for boiler feed. The shops are of such extent that the transmission is comparatively long for a works installation, and most of the machinery is light, so that group drive is preferable to individual motors. The

Compressed air was wanted for shop and foundry use and water for toilets and washing, which could, of course, be taken from the lake. There will be no use for the exhaust steam in summer, as the operations of the plant do not call for it, so that the power units should be made condensing for that season.

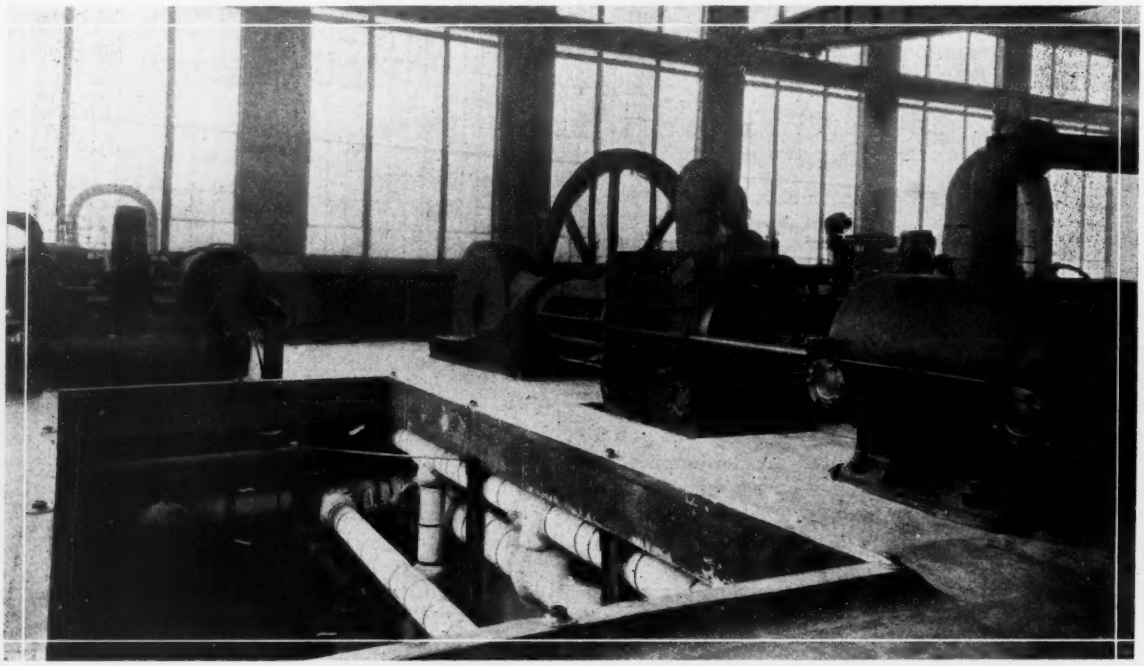


FIG. 2. AIR COMPRESSORS AND PUMP PIT

shops are situated on a high bluff, hence the lifting of cooling water for the condensers would be quite a large item, but coal comes by rail and can most conveniently be dumped from hopper cars. Heating of the shops

General Solution of the Problem

Consideration of the conditions will show that the logical location for the power house was on the shore and at near the level of the water, but as there was no

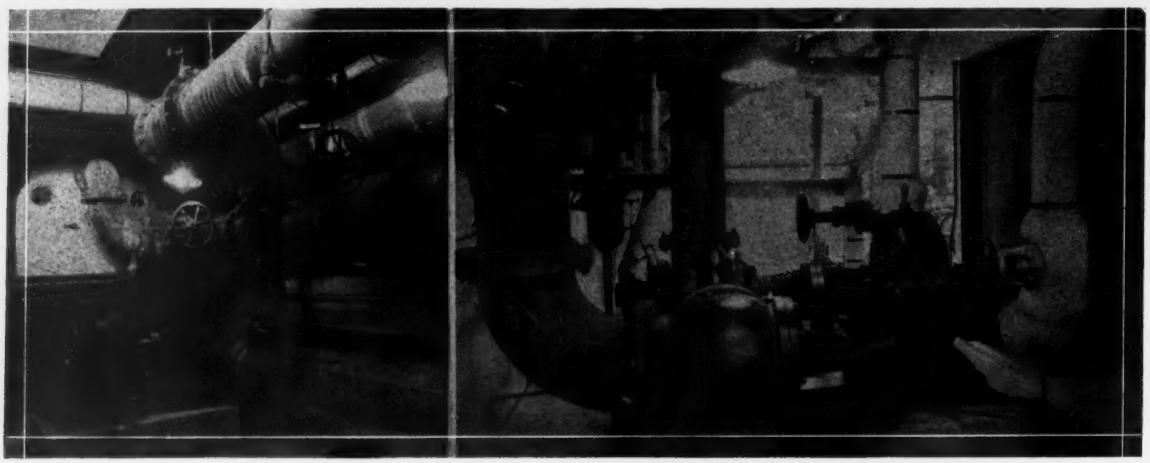


FIG. 3. CIRCULATING PUMPS FOR HEATING SYSTEM

calls for an even temperature, but not of high degree to be the most comfortable for working, and the size of the shops is such that the ventilating problem need not be considered, as the natural supply of air is sufficient.

room for such a building, it was necessary to excavate, and the cost of that work made it desirable to have the plant take up as little ground as possible. The distance of transmission made the use of medium voltage alter-

nating current advisable so that it might be stepped down readily for lights and motors, and the constant speed for driving group shafting presented no serious obstacle to this plan. As the city water was to be used for boiler feed, it was desirable to re-use it, and to return it as hot as possible to the boilers; also to keep it free from oil and scale which might come from the heating system.

Location of the house at the foot of the bluff gave a chance to deliver the coal direct into the bunkers from the cars and draw it to the chutes and stokers by gravity, also to get the cooling water with but a short lift, and the amount needed for toilets and wash water must be lifted anyway, but is comparatively small in weight. By using the exhaust steam to heat water, which in turn is pumped to the shop for hot water heating, the system can be made closed so that the weight of the returning column balances that of the ascending, and the work of pumping is reduced to that called for by the friction in the pipes. Further, by this method, the exhaust steam is condensed at the power house and can be returned at once to the boilers, and the use of turbines frees it from oil and from the possibility of scale and dirt from the heating pipes.

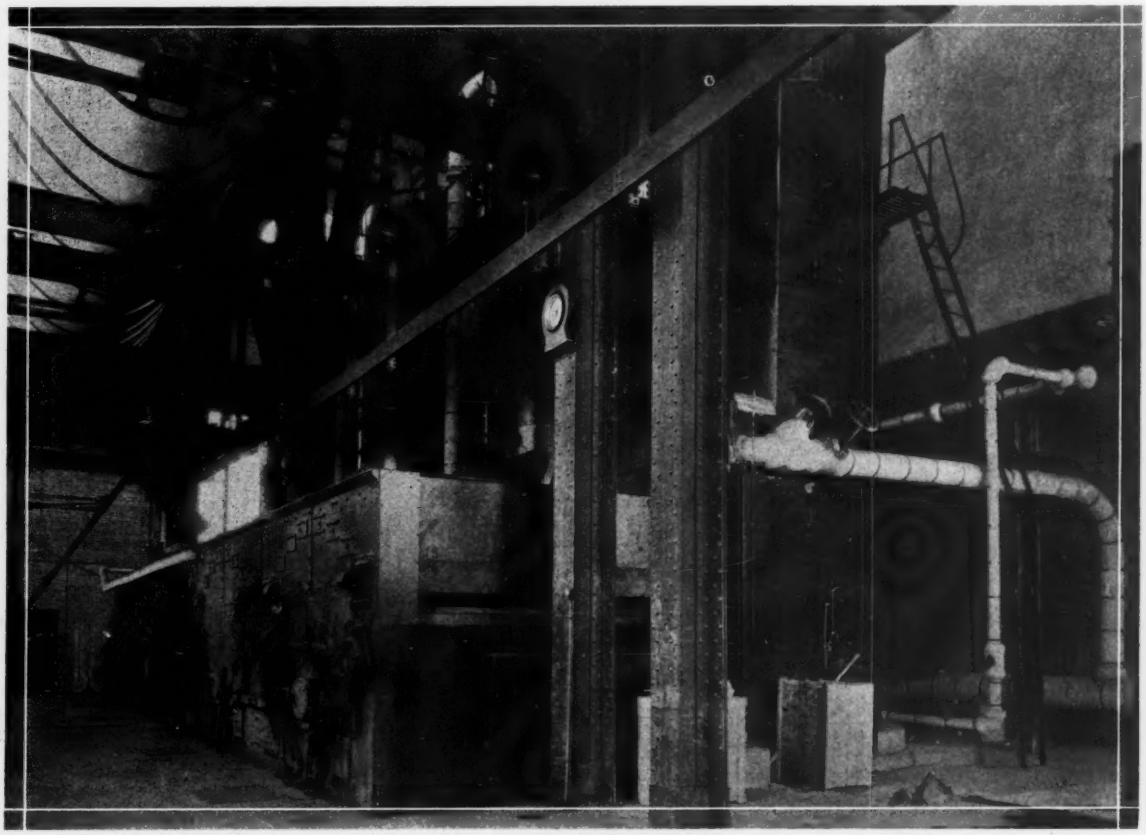


FIG. 4. VIEW OF BOILER ROOM SHOWING BUNKERS AND WEIGHING CHUTES

LOCATION

IT WILL be seen from the exterior view that turbine and boiler rooms are in one building, with the boilers next the bank, so that a track is carried onto the roof above the boilers and the coal dropped direct into the bunkers. Also the turbines are placed next to the lake, giving the shortest possible path for the in and outflow of the large volume of cooling water. As the shops are located fronting a street which leads to the lake, the plant is at the end of this street, and the tunnel for carrying the piping and wires to the shops is placed so that the top forms the walk which runs in front of the shops, thus making the tunnel accessible, and using the top of the tunnel as the sidewalk for the street. The location below the bluff, made the installation easy, also, as the handling was a lowering rather than a lift, and the use of vertical boilers to save floor space made the use of a tall building necessary, which, in turn, gave room for the gravity handling of coal and ash, and fine headroom for crane and light in the turbine room.

THE PLANT

SHORE SANDS do not make the best of foundations, hence, it was necessary to go to clay bottom 3 to 4 ft. below lake level with concrete footings. Above these foundations were built walls of pressed brick with roof of tile and steel frame where necessary to support the structure and the crane.

The boiler room has a floor somewhat lower than the turbine room in order to give room below the turbines for the condensers, pumps and other apparatus needed there. Also the boilers need more room above the foundations than the turbines, as there must be a chance to

get at the tubes from the top. Below the boilers is provision for the ash hoppers and a tunnel from which the ashes can be taken in barrows. This gives clear headroom above the turbines to the roof, which allows of plenty of air and splendid light. Inside, the walls are of pressed brick of a pleasing tan color, giving good reflection of light but freedom from dinginess after a period of use. Windows are carried the full height of the room, with translucent glass to give freedom from glare and a diffused light, and this same pleasant diffusion is secured at night by the use of 4-light clusters of tungstens placed near the roof and so spaced that there is plenty of light for any of the usual work that could be performed even in daytime without the use of work lights.

FIG. 5. EXTERIOR VIEW OF PLANT

For handling the machinery in the turbine room and basement a 20-ton girder crane is installed, running on I beam tracks and having the travel and hoist operated by hand chain blocks and sheaves, this equipment being furnished by The Whiting Foundry and Equipment Co.

Even with the power house located at the lake level, there remained the problem of how to take the water from the lake. An intake carried out to get the water free from shore dirt, and so that it would withstand the action of the waves, would cost some $30,000, which seemed too large an investment; and even if a shorter intake were used, it would still cost some $10,000 for a structure which would not be satisfactory, and would be likely to cause trouble. It was decided, therefore, to try the use of a well at the shore, and to take the water to it through an intake pipe and rack, trusting to keep the entrance clear by some means. An open well was then built of concrete, 20 ft. diameter and 20 ft. deep, with a screen rack at the entrance to the cast-iron filler pipe in the retaining wall at the outside of the foundation. With the first northeast storm, however, the entrance promptly filled with sand, and the "somehow" had to be devised for keeping it clear. A breakwater was accordingly built of the shape indicated in the sketch, the upper end being made of 2 rows of sheeting filled between with stone and the south end, which is most protected from the action of wind and wave, left with rack openings to let in the water. The opening was then dredged out and it is found that there is no further trouble, as the action of the water seems to be to keep the entrance to the breakwater clear rather than to fill it in.

Water comes into the well through a 36-in. pipe and is led to the plant by a pipe which is 30 in. in diameter as

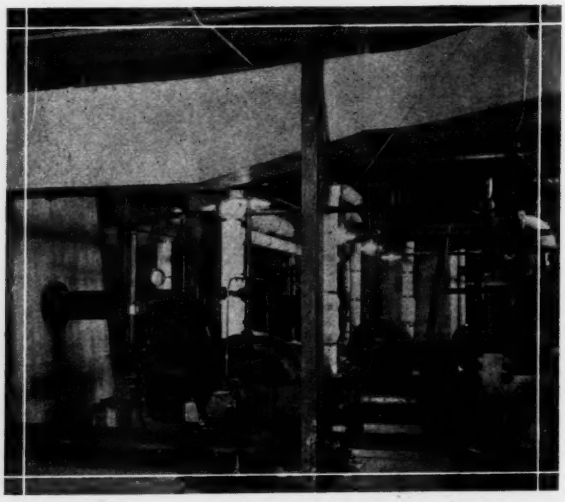


FIG. 6. CIRCULATING AND CONDENSATE PUMPS OF TURBINE CONDENSERS

far as the first condenser, and 24 in. beyond that point. It has connections for supplying the condensers, the toilet and wash water, and the fire system.

Power Supply

For supplying the power needed, Curtis horizontal steam turbines were chosen for the generating units, partly because of the small space required, partly because the steam needed for the heating system could be readily "bled" from the intermediate stage. The units are 2 in number, with room for more as needed. They are of 750 kw. capacity, generating current at 2300 volts and 60 cycles, delivered direct to line at this voltage, and running at 3600 r.p.m. The current capacity is 235 amperes, 3 phase, and the power rating is with a power factor of 80 per cent. The units are designed to run with a pressure of 175 lb. at the inlet and condensing exhaust, but as much steam as may be needed

for heating to supplement the steam from the compressors and auxiliaries can be taken from the first stage by "bleeding" after it has done work in the first set of wheels.

Lubrication for the turbine units is furnished by centrifugal pumps driven by the turbines and located in the base, but for starting up, or emergency use, a Dean Bros. pump is mounted at the side of the unit with cylinders 4 by 2⅝ by 5 in.

To indicate and control the action of each turbine, a gage board is installed, equipped with Ashcroft gages, showing the initial pressure, that in the first stage, that in the exhaust from the last stage, and a mercury column gage to check the readings of this last.

Exciting current is supplied by either of 2 units; the first is a motor generator set, consisting of a 54-hp. Allis-Chalmers induction motor taking 2300-volt, 3-phase current and driving a 125-volt direct-current generator of 280 amperes capacity at 860 r.p.m. The other exciter is driven by an Allis-Chalmers 35-kw. turbine at 3600 r.p.m. and is of the same capacity as the first.

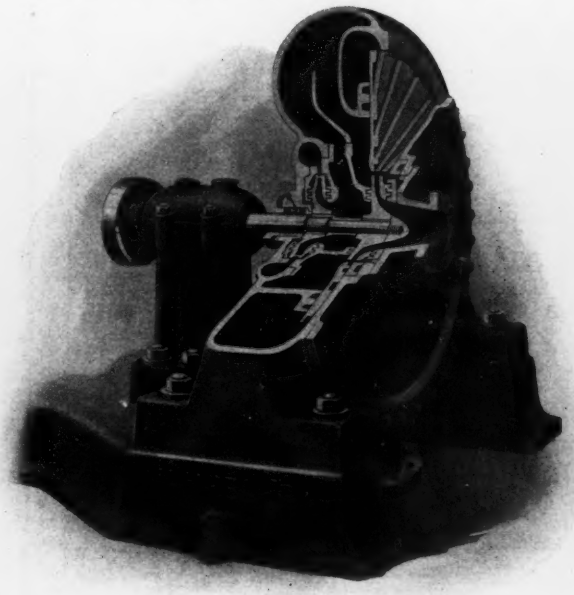


FIG. 7. SECTIONAL VIEW OF CONDENSER PUMP

The large duplex air compressor is of Allis-Chalmers make with cylinders 20 and 34 by 36 in. and with 2-stage air cylinders 28 and 16 by 36 in., having positive inlet valves and delivering air at 100 lb. pressure. Richardson sight feed oil pumps are used with a Phenix-Richardson multiple filter to purify the oil after using. The small compressor, which is for use when the demand is light, is an Ingersoll-Rand, Imperial type, with steam cylinders 11 and 22 by 16 in. and air cylinders 19 and 12 by 16 in., likewise delivering at 100 lb. Air is discharged from either compressor to a receiver in the basement of the turbine room, an unloading device permitting the compressors to run idle if over-pressure is reached in the receiver. A board with Ashcroft gages shows all pressures on the compressor system. Exhaust from the compressors is to the heater for the shop system through an oil separator, or part may be taken to the feed-water heater.

Heating System

The hot water system of heating with forced circulation is that installed by the General Fire Extinguisher Co., with the heat furnished by the exhaust from the air compressors and pumps, and as much more as may be necessary from the first stage of the turbines. For heating the water, a large heater is placed in the turbine room, with the lower part extending to the basement, and the water is circulated through this and the heating system by centrifugal pumps.

All pressures and temperatures of the system are registered in the turbine room on a gage board equipped with Schaeffer and Budenberg instruments, which show the outgoing and return temperatures, the difference varying with the temperature and the speed of circulation; the head on the circulating pump, that on the expansion tank, and the back pressure on the exhaust system from the heater.

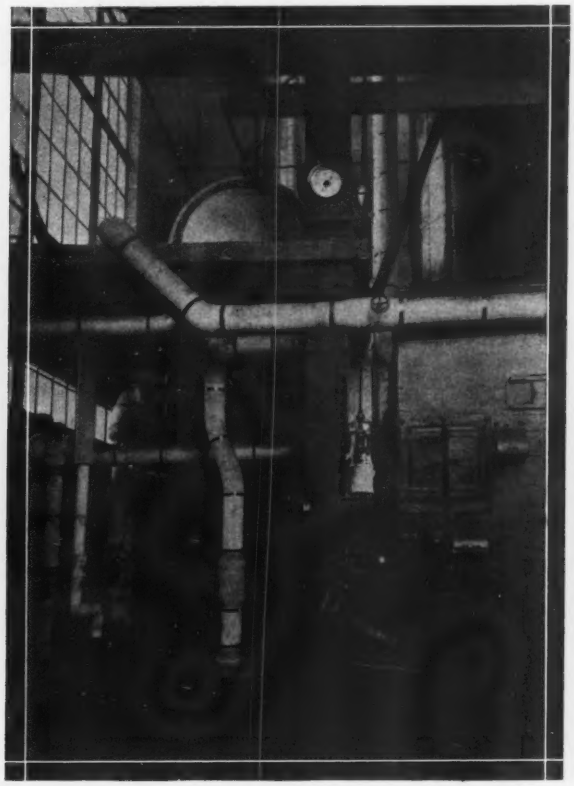


FIG. 8. BOILER FEED PUMP AND HEATER PLATFORM

For circulating the water in the system, duplicate pumps are provided in the basement near the heater, one being driven by a De Laval steam turbine and the other by a General Electric motor. As the system is closed, the work done by these pumps is only that needed to overcome the friction in the pipes, so that a large volume of water can be handled with only a small amount of power. The De Laval turbine operates noncondensing and exhausts into the heater. The motor is

of 75 hp. at 1200 r.p.m., using 220-volt current, and the pumps are De Laval of 2300 gal. per min. capacity when operating against 70 ft. head. On each side of each pump is a Wainwright corrugated copper expansion joint to care for the variation in the temperature of the water without disturbing the adjustment of the pumping units.

lead covered cable is used, suspended by iron straps from the ceiling beams in the basement of the turbine room, and from the sides of the tunnel. These cables and the pipes for water and air are carried up to the ground level at the back of the boiler room and led into the tunnel already mentioned, which is 7 ft. high by 9 ft. wide.

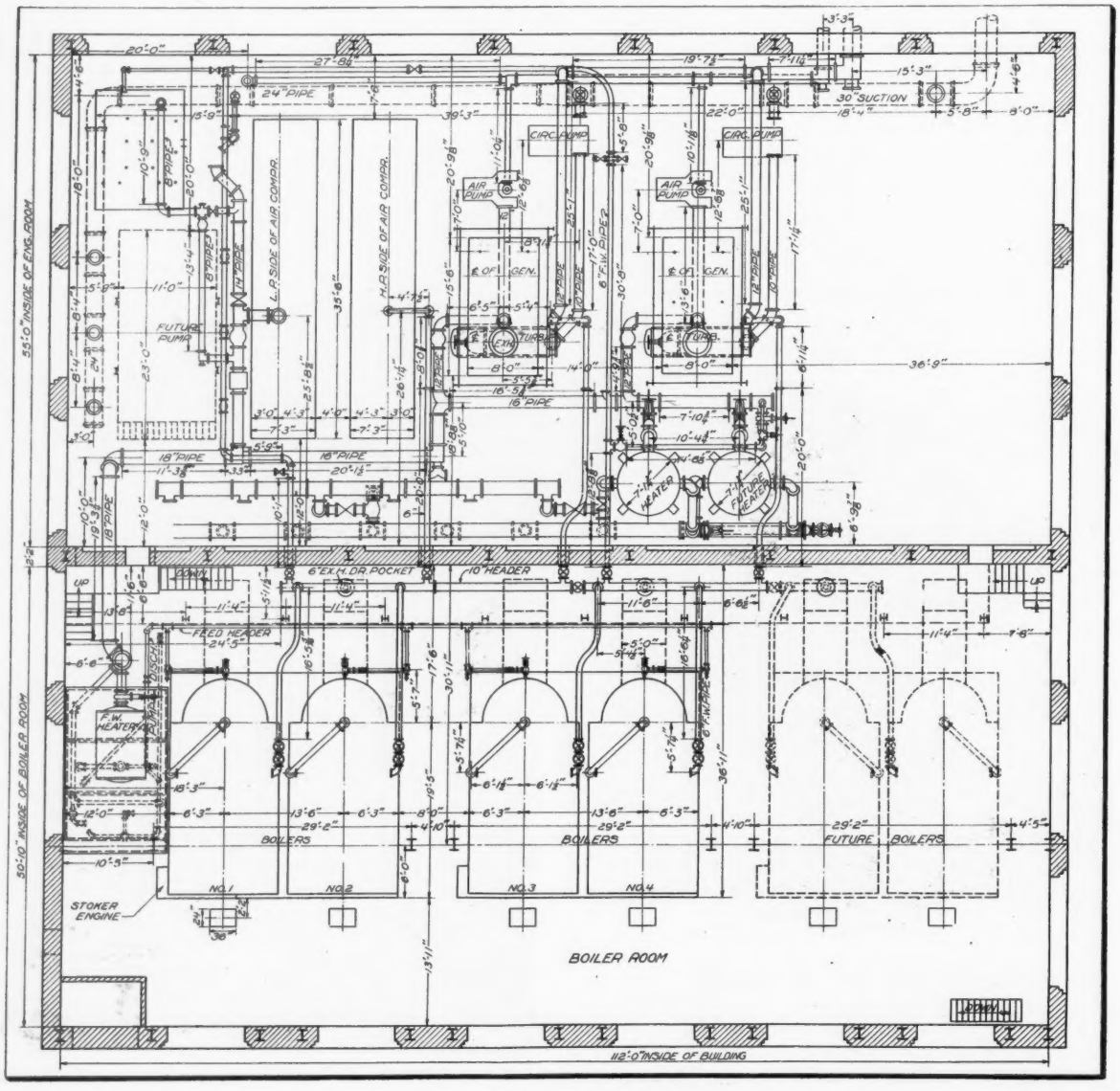


FIG. 9. PLAN OF POWER PLANT

Current Distribution

Current at 2300 volts and 60 cycles is carried out to the lines direct from the switchboard, and is stepped down at the places where wanted to 220 volts 3 wire for lighting and motor load, with rotary transformers to give direct current at 250 volts where wide variation of speed control makes such current desirable, as in direct driven tools and crane motors. From the generators to the switchboard the cables are carried in conduits beneath the floor, and for distribution to the shops,

Control of the generation and distribution is through a switchboard located in front of the turbines and having the front of slate fitted with instruments and control switches, while all the high tension current is kept at the back on a piping framework near the wall. There is plenty of room between the 2 for comfortable and safe working, as there is at all points in the entire plant.

Beginning at the left, the first panel is for the exciter units, both of which are controlled from the one panel. On the second are the registering voltmeter and

recording wattmeter, and on the third control apparatus for the motor of the exciter set. The fourth and fifth panels control the generators, the instruments including wattmeter, voltmeter, ammeter which can be connected into any phase; field ammeter; speed indicator, which reads in percentage of speed above or below that required to give 60-cycle frequency, and the switch control handles.

Two feeder panels are mounted with 2 feeders to a panel, each having a time limit relay breaker, ammeter and integrating wattmeter.

furnace and falls into the same pit, from which it runs through doors at the height of the barrows in the ash tunnel below direct into the barrows, and is wheeled out and dumped to form a fill at the edge of the lake. Thus no lifting of fuel or ashes is required at any point in the process.

All condensation from the plant is led to the feedwater heater, that from the main turbines coming from the condensers and that from the water heater being returned by special pumps. Exhaust from other auxiliaries comes direct, as steam, to the feed heater, which is

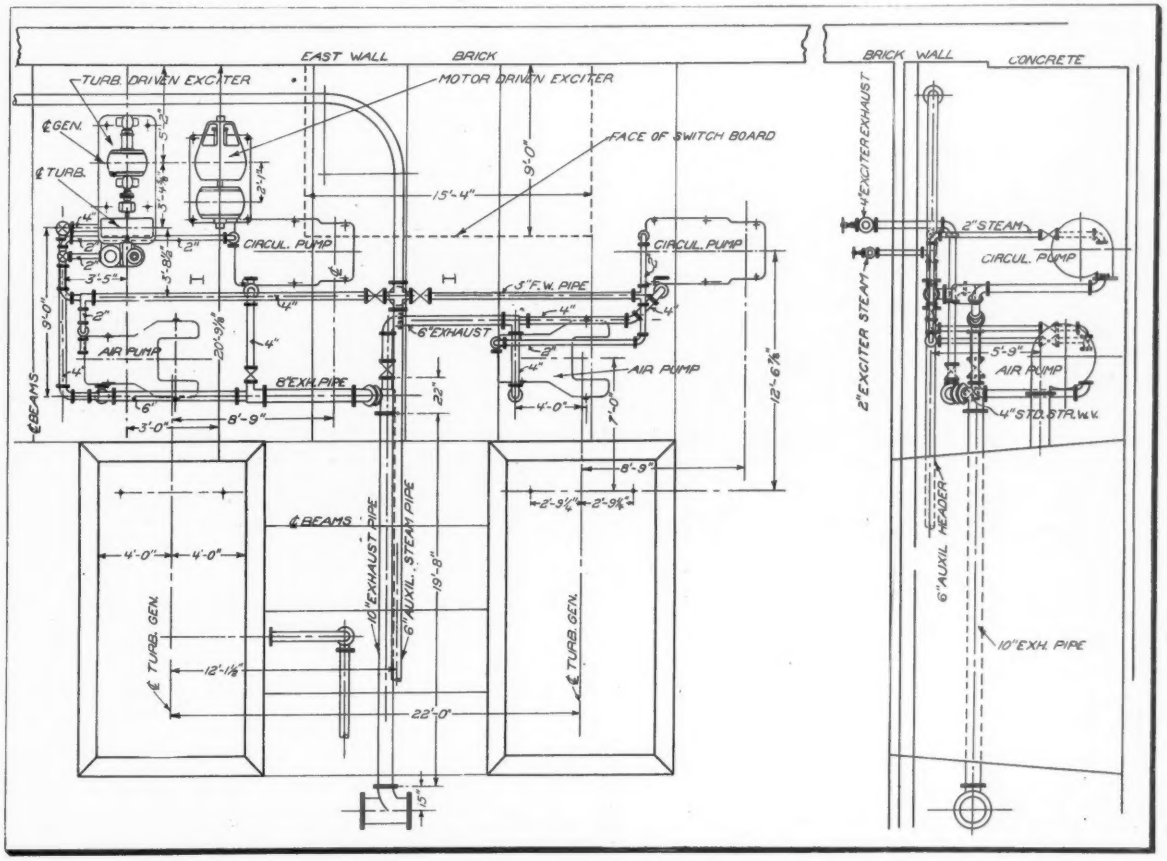


FIG. 10. STEAM AND EXHAUST PIPING FOR TURBINE DRIVEN PUMPS AND EXCITER

Boiler Room

In the boiler room are installed 4 Wickes vertical water-tube boilers of 500 hp. each, with Detroit stokers and Foster superheaters. Youghiogheny screenings are brought in hopper cars to the roof of the building and dumped direct into the suspended-type bunkers, which were supplied by the Brown Hoisting and Conveying Machinery Co., and from these bunkers the coal falls by gravity through the gates and chutes to the scales, furnished by the Standard Weighing Machine Co. As each load is drawn, a record is punched on a card by the machine, thus giving a complete tally of the coal burned. The coal then passes to the hopper of the stoker and is fed as needed by the stoker engines, whose speed is regulated according to the demand for steam.

Ashes drop from the stoker to an inclined-floor ash pit below, and clinker is hauled from the front of the

a Hoppes open type, and make up water needed is supplied from the city system through a float valve. Exhaust which comes to the heater through a large main leading from the basement of the turbine room, may pass to atmosphere, when there is a surplus, through a Hochfeldt Eclipse relief valve made by the John Davis Co. Boiler feed pumps draw their supply direct from the heater, which is located on a platform above so that all possibility of steam binding is avoided.

To feed the boilers there are 2 pumps, the one generally used being a 3-stage De Laval centrifugal with capacity of 250 gal. per min. at a speed of 2800 r.p.m. against 462 ft. head, direct driven by a turbine of the same make, which operates at 170 lb. boiler pressure and exhausts atmospheric into the feed heater. As a reserve, a Marsh single-cylinder pump is installed, made by the American Steam Pump Co.

Full equipment of Crane blowoff valves, cocks, Craneweld high-pressure piping and valves and fittings is used with each boiler, also Consolidated safety valves, Wright improved safety water columns with P. B. H. self-closing gage cocks and Ellison draft gages. Dampers of the louver type in the breeching of each boiler are controlled from the front by hand levers in accordance with the steam and pressure requirements. Inspection landings are placed at the top of the boilers and at the level of the water gages. Ample natural draft is insured by the brick stack, which is 8 ft. diameter by 225 ft. high and is lined with fire brick for 50 ft. of its height. To carry the flue gases to this chimney, a reinforced concrete uptake runs along back of the boilers and is connected to the bottoms of the boilers by sheet iron uptakes.

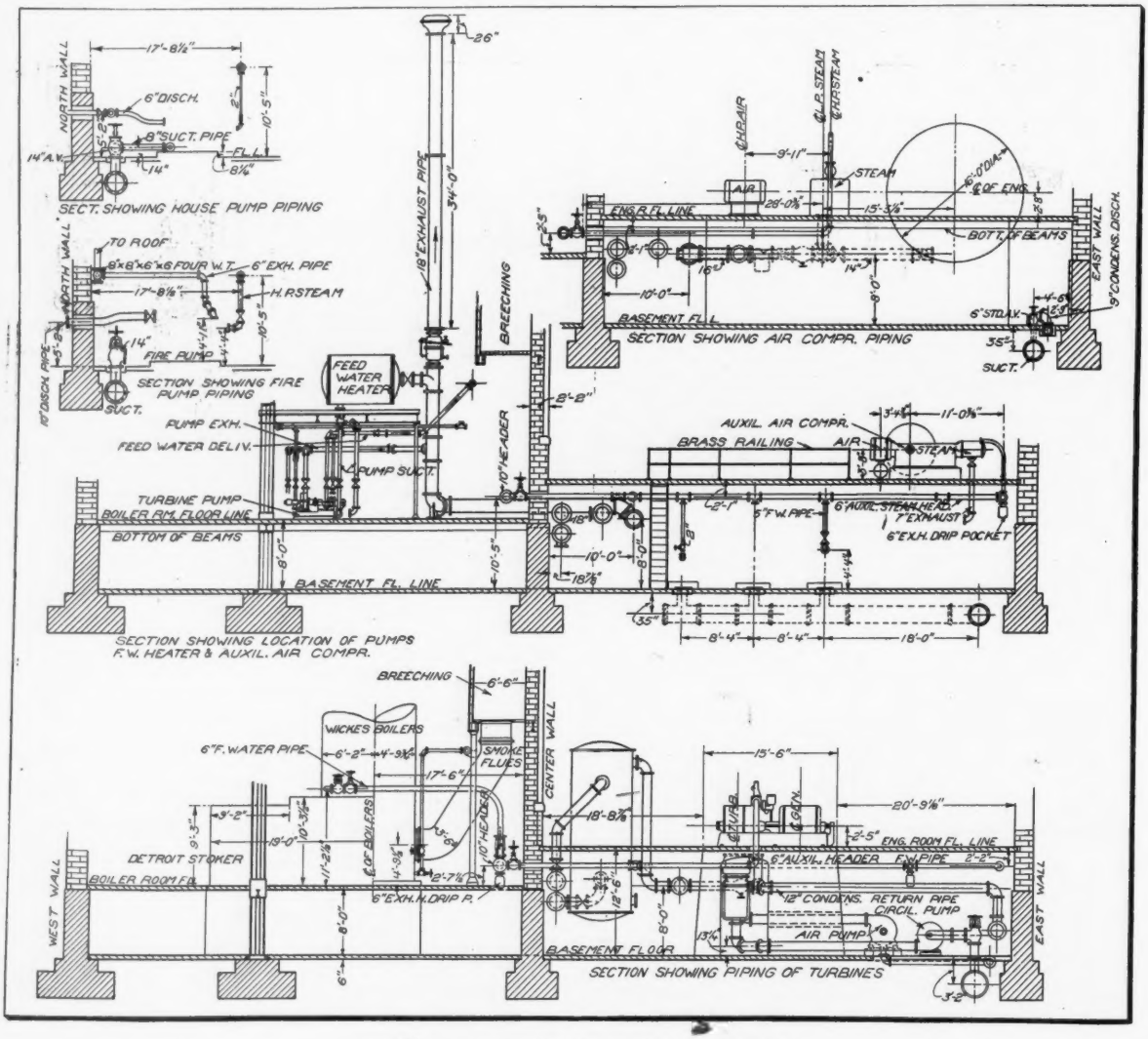


FIG. 11. ELEVATIONS OF PLANT AND PIPING

Pump Equipment

Condensation from the hot water heater is pumped to the feed heater by a Deane of Holyoke duplex simple pump 12 by 4½ by 12 in. with McCord force feed oiler and a Boylston trap to remove condensation from the steam supplied to the steam cylinder. From the toilets and washrooms, the water is supplied by a compound duplex pump, 10 and 16 by 12 in., having its steam supply controlled by a Fisher governor to keep the pressure on the water system at 70 lb., the water supply being drawn from the intake pipe leading from the well on the shore. For fire purposes, there is a Fairbanks-Morse pump with cylinders 20 and 12 by 16 in. and having a capacity of 1500 gal. per min. when running at 60 r.p.m. and against 70 lb. pressure.

Next to this fire pump in the pit under the air compressor, and getting natural daylight through an opening in the floor, is the condenser for summer use with the compressors when the steam is not needed for heating. This is of jet type, made by Dean Bros. of Indianapolis, with vertical pump 10 by 22 by 15 in. The condensers for the turbine generator units are located directly beneath the turbine to give short connections, and are from the Wheeler Condenser and Engineering Co. The cooling water pumps are No. 10 centrifugals

made by the same company with double inlet from the lake inlet pipe and discharge through the condensers to the outlet pipe, which returns direct to the lake. For removing the air and condensate, divided inlet centrifugals are used, the air and condensate being handled by the same pump, but separated, the air going to atmosphere and the condensate to the feed heater. All these condenser pumps are driven by Terry steam turbines, which exhaust to the heater.

The combined pump handles both condensate and air, which enter through a single inlet, shown coming from the bottom of the condenser in Fig. 11. Just inside the inlet nozzle is a partition to separate air and water, as shown in the section of the pump, Fig. 7; water runs down at the left to the eye of the condensate impeller, which is of ordinary centrifugal design, and discharges into the small spiral at the left and out through the condensate pipe, which is attached at the rear of the casing. Air is drawn over the partition to the center of the right-hand compartment and enters the grooves in the plate between slugs of water, which are thrown by the "hurling" impeller. It is carried out to the oval spiral at the right behind the grooved plate and flows

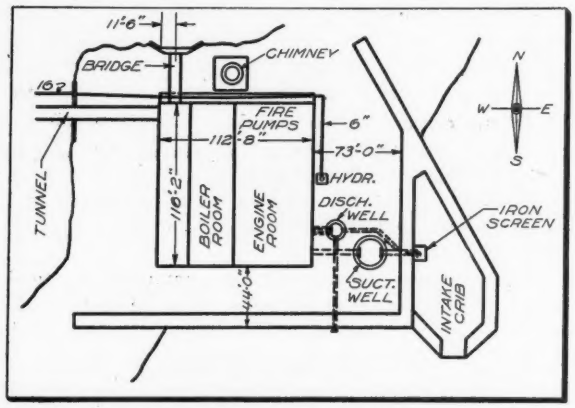


FIG. 12. ARRANGEMENT OF BREAKWATER ABOUT INTAKE

away from the casing through a pipe at the back. Cool hurling water is brought from the house supply and drains away through the outlet at the bottom of the casing. Test readings taken in January showed that with inlet water at 34 deg. F. the outlet water was 40 deg. and the condensate 39 deg., and the temperature of the exhaust from the condenser was 55 to 51 deg., with a vacuum corrected for 30 in. barometer of 29.44 to 29.53 in.

This arrangement gives 2 pumps in a single casing, but entirely independent so far as action is concerned, reduces the piping between condenser and pump, saves in space and driving power required. The action of the hurling water was explained in the issue of Oct. 15, 1913, p. 1020.

Steam pipes are dripped and separators are provided wherever necessary, Squires traps being adopted as the standard for use in returning the water to the heater. Connection from the boilers is by long bends to a header, which is below the level of the turbine room floor so that the supply is taken horizontally from this header beneath the floor and rises to the turbines. For the pumps and auxiliaries, a second header is used, which is led around the walls of the basement of the turbine room and branches taken off where most convenient. Exhaust piping is carried just below the level of the turbine room floor and is so connected that the steam may be carried to the heater, the feed water or to atmosphere, as requirements or emergency may demand. All piping is arranged so that it can be easily gotten at for repair or alterations and shows the careful planning of the chief engineer, Robert Anderson, to whom we are indebted for much of courtesy and assistance in the preparation of this description. All piping for steam or hot water is covered with H. W. Johns-Manville 85 per cent magnesia insulation, as Mr. Anderson has not intended that any venturesome heat unit that can by any means be induced to stay in the path of virtue and perform its proper work shall be permitted to stray from the direct course of duty.

Steam Heating

DIRECTIONS FOR CALCULATING NECESSARY HEATING SURFACE. BY WILMER R. HERSEY

THE engineer of the small factory frequently has to put in a steam heating coil, in some part of the factory that does not warm up to the required temperature; or coils to warm an addition that has been built onto the original building.

The purpose of this article is to give a few simple rules and suggestions that will help in designing coils that will use either exhaust steam at a few pounds above atmospheric pressure, or live steam as the case may require.

The first thing to find out in designing a coil to heat a room is the amount of radiating surface required.

To find the radiation needed per square foot of equivalent glass surface, use the following formula:

T_1 = the temperature at which it is desired to keep the room in degrees F.

T_2 = the coldest outside temperature in degrees F.

T_3 = the temperature of the steam used in the coils in degrees F. This may be found in the steam tables to correspond with the pressure used.

$$\frac{(T_1 - T_2)}{(T_3 - T_1)} = \text{The square feet of radiation required}$$

per square foot of equivalent glass surface.

The square feet of wall surface is equivalent to one square foot of glass surface. The total equivalent glass surface in a room is equal to

$$\frac{\text{(Exposed wall surface} - \text{window surface)}}{10} + \text{window surface.}$$

To the amount of radiation as found by multiplying the results of the formulas given above must be added from 20 to 50 per cent, to allow for ventilation, air leakage and exposure to high winds.

A room that is exposed to high winds, or has many windows, or doors that are opened much, should be allowed a more liberal percentage than would be allowed to a room without outside doors, or a room with only one exposed wall, etc.

AN EXAMPLE WORKED OUT

FOR EXAMPLE, suppose a foreman's office has been built in the corner of a factory on the south and west

walls. The room is 12 ft. high and 10 ft. on the west wall by 14 ft. on the south wall. There are 3 windows 3 by 6 ft.

The factory is heated to 60 deg. F. It is required to heat the office to 70 deg. F. with an outside temperature of 10 deg. F.

There are no outside doors, but the door between the office and factory will be used often. The room is to be heated with exhaust steam at a pressure of 5 lb. gage. The inside walls are not considered as exposed surface, but the difference in temperature in the factory and office should be taken into consideration when making the addition to the radiating surface for ventilation, etc.

The temperature of exhaust steam at 5 lb., as taken from the steam tables, is 227.9 deg. F., or let us say 228 deg.

$\frac{[70-(-10)]}{(228-70)} = \frac{80}{158} = 0.5063$ sq. ft. of radiation per square foot of equivalent glass surface.

Equivalent glass surface $= \frac{[12\times(14+10)-3\times3\times6]}{10} + 3\times3\times6+54 = 77.4$ sq. ft., and $77.4\times0.5063 = 39.18$ sq. ft. of radiation required.

Now add to this an amount to cover the air leakage, the cold west exposure and the difference in temperature of the office and the factory.

Add about 25 per cent for the west exposure, etc., and about 10 per cent for the difference in temperature of the office and the factory. This will make a total of 35 per cent of the radiation found, to be added. $39.18\times1.35 = 52.89$ sq. ft. of radiation required. Let us say 53 sq. ft.

The next thing is to determine where to locate the coil or coils; in this case it would be best to use 2 coils, then in mild weather one could be shut off, the other furnishing all the heat necessary.

The coils should be located on the outside walls under the windows, the pipes to run horizontally, and should be about 6 pipes high.

We will put about half of the radiation on the west wall, as that is the coldest side. This side of the room is 10 ft. long; to allow for clearance at the ends of the coil, use a coil 9 ft. long. Six pipes 9 ft. long = 54 ft. of pipe in this coil.

We will now find the size of pipe to use on the job. Half of the radiation is 26.5. Half the radiation divided by the length of the coil in feet gives the area of the pipe required per foot of length or $\frac{26.5}{54} = 0.472$ sq. ft. per foot length.

Now looking in the table of standard pipe we find that 1½-in. pipe gives more and 1¼ a trifle less than the desired radiation for this coil; therefore we will use a 1¼-in. pipe for the job.

The area in square feet per foot of length as given in the table for a 1¼-in. pipe is 0.435.

To find the radiation in this coil, multiply the length of the pipe in feet by the area in square feet per foot of length, or $54\times0.435 = 23.59$ sq. ft.

The coil on the south wall must have $53-23.59$ or 29.41 sq. ft. of radiation.

To find the length of pipe required in this coil, divide the total radiation required by the radiation per foot of length, or $29.41\div0.435 = 67.6$ ft. of pipe required. The length of the coil will be $67.6\div6 = 11.26$ ft., or say 11 ft. 3 in., and the radiator surface will be $6\times11.25\times0.435$ or 29.36 sq. ft., which is near enough.

A good approximate rule for steam supply mains not over 2½ in. in diameter is that one square inch area of pipe will supply 100 sq. ft. of radiation, at 5 lb. steam pressure; or 50 sq. ft. of radiation, at 2½ lb. pressure, for mains not over 100 ft. long. One square inch of area will supply about 70 per cent of the above radiation for mains from 100 to 200 ft.; and about 55 per cent for mains from 200 to 300 ft.

No pipe smaller than one inch in diameter should be used for a steam main. The return mains should be from 1 size with the small pipes to 2 sizes with the larger pipes, smaller than the steam main.

To find the amount of expansion that must be cared for in the mains or coils, multiply the length of the pipe in feet, by the greatest difference in temperature between the pipe and the room in degrees F., and by the coefficient of expansion for the pipe. The coefficient of expansion for iron pipe is 0.000,082,32 in. per foot, per degree difference in temperature.

In the example of the room given above the temperature of the steam used is 228 deg. F., suppose the lowest temperature allowed in the building is 50 deg. F., the steam main is 100 ft. long. The expansion to be cared for in the pipe is $(228-50)\times100\times0.000,082,32$ or 1.47 in.

In the case of a room that does not warm up to the required temperature, and needs a coil to help out the present heating system, when designing the coil, instead of using the coldest outside temperature for T_2, in the formula, use the temperature to which the room will heat on the days when the temperature outside is at the lowest point.

For example, suppose it is necessary to heat the office in the case given, to 85 deg. F., instead of 70 deg. F. with an outside temperature of —10 deg. F.

The office will already heat up to 70 deg. F. and to find the amount of radiation that must be added, the formula becomes $\frac{(85-70)}{(228-85)} = 0.1049$ sq. ft. per sq. ft. of equivalent glass surface.

The amount of radiation necessary will be 0.1049×77.4 or 8.12 sq. ft. of radiation. This is to be added to the radiation already in the room.

STANDARD PIPE

Normal Size, inches	Radiating Surface, sq. ft. per ft. of length
¾	.275
1	.345
1¼	.435
1½	.498
2	.622
2½	.753
3	.915

A Scientific Governor

AN INCLOSED GOVERNOR WITH KNIFE EDGE BEARINGS EFFECTS REGULATION WITHIN ¼ PER CENT AND APPROACHES ISOCHRONOUS GOVERNING

REGULARITY of speed on a steam engine is such an important matter that reference may be permitted to a governor which in Great Britain has secured a considerable degree of favor. The want of stability in a governor leads to excessive surging or hunting in the speed of the engine, a fault which nowadays is too serious to be permitted. Isochronous governors have been designed theoretically, giving a uniformity of speed; but in order to avoid hunting trouble, it is often the case that these are designed so as to require a considerable alteration of speed to move the weights from one position to another.

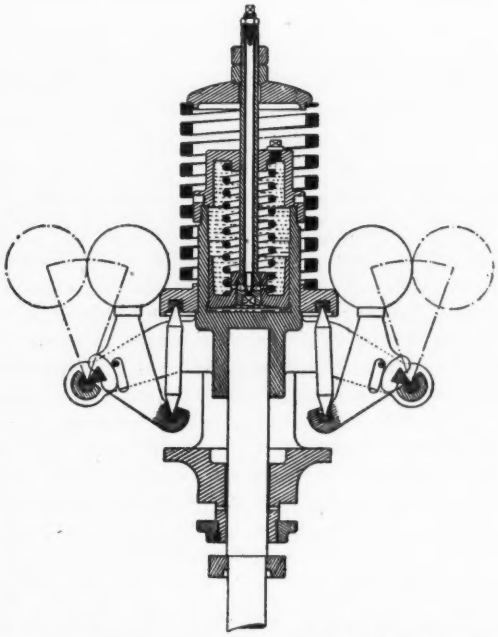


FIG. 1. SECTIONAL VIEW OF THE IMPROVED WHITEHEAD GOVERNOR

The duty of a governor is to operate or alter some portion of the mechanism of the engine, such as the throttle valve or the cutoff gear controlling the amount of steam admitted to the cylinder; other attempts have been made to get the uniformity of speed of the engine by adjusting these controlling mechanisms by auxiliary means, such as winding or ratchet gears for lengthening or shortening the connection to the valve or gear, while at the same time maintaining an approximately middle position of the governor; hence, the governor controls small variations of load directly, and larger ones through the intermediary of the auxiliary mechanism. Where the load variation is small, such means are satisfactory, but on account of slowness in working they are often unable to deal with quick variations of load. The slowness, which introduces an element of danger, makes it necessary to fit a safety knock-off arrangement to prevent the running away of the engine, while for obvious reasons simplicity is desirable.

The original Whitehead governor is well known, but it has recently been redesigned and the improved type of Whitehead governor possesses a considerable number of interesting points which need mention. The governor as now made by the Monovel Governor Co., of Bury, England, utilizes knife edges to reduce internal friction, and it is now possible to run the governor practically without lubrication. Figure 1 shows the section. The body is made in the form of an oil dashpot, on the outer portion of which slides a governor sleeve, and having at the bottom a double cross bar which supports, by knife edges, the bell cranks which form the operating weights.

The lower portion of the sleeve is in the form of a bobbin, in which works a collar, transferring the movement to the levers. The upper portion bears against the

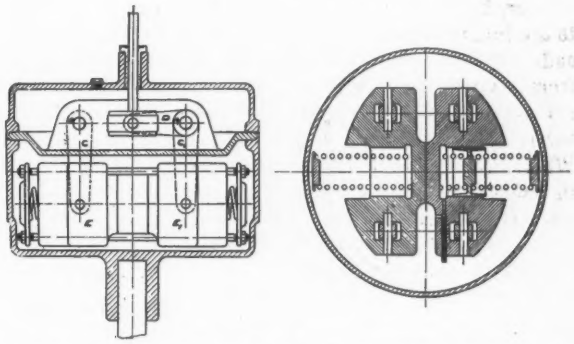


FIG. 2. SECTIONAL VIEWS OF THE CHORLTON-WHITEHEAD GOVERNOR

external spring, which partially counteracts the centrifugal force of the weights transmitted to it by the pencil rods from the bell cranks. The top of the external spring presses against the plate attached to the central piston rod of the dashpot, while between the dashpot piston and cover is placed an internal spring in such a way that this compresses when the external spring is compressed. The central piston rod is hollow, and contains, in a conveniently adjustable position, the valve controlling the passage of oil from one side of the dashpot piston to the other, and, therefore, the rate of movement of the piston. The remaining centrifugal force not counteracted by the outer spring is exactly balanced by the inside spring, and if the dashpot valve is wide open the 2 springs exactly balance the centrifugal force of the weights in all positions at the designed speed of the governor.

Working under these conditions with the valve wide open, the piston free to move, the governor would have no stability and would hunt badly. On the other hand, if the valve is closed, the dashpot piston becomes immovable and puts the inner spring out of action. The govern-

or would then work with the outer spring only, and naturally considerable variation of speed would be necessary to move it from one position to another. This speed would in most cases be too great to obtain good governing of the engine. If, however, the dashpot valve is partially open, so as to allow the dashpot piston to move slowly, the inner spring will come into action and a point of the adjustment can be found where the movement is slow enough to prevent the governor from hunting, while at the same time it is amply good enough to give excellent results with the most variable forms of load on the engine. The adjustment of the valve is capable of a considerable range, allowing the best results to be obtained for every condition of working.

An ingenious and simple adaptation of the principle underlying the Whitehead governor is the Chorlton-Whitehead type, this being of the totally enclosed description. It combines what is probably a maximum of power that it is possible to obtain in a governor of given size and speed, with a close approach to isochronous governing. Under reasonably favorable conditions, a variation not exceeding ¼ per cent from the main speed throughout the full range of load, is obtainable without the hunting which is so often the result of attempting too fine an adjustment of governors. The external form of the governor is a polished cylindrical casting, forming a chamber, filled with oil in which the internal working parts are immersed and the connection to the valve gear is made either from a spindle projecting from the top or from a sleeve underneath the body. In the former case it is not necessary to provide a sleeve, as the projecting spindle does not necessarily revolve.

When taking the valve gear connection from underneath the body, however, the sleeve revolves and the motion has to be taken off by means of the clip or dies, as usual in ordinary practice. The former type is one particularly adapted for use with vertical engines, as the small number of joints necessary in coupling up reduces friction and lost motion about all joints to a minimum. Where the speed has to be varied during running, a separate speeder spring can be introduced into the governor gear, preferably as near the governor as possible; but, this arrangement cannot fail to affect somewhat adversely the sensitiveness of the governor, and it is not adopted unless absolutely necessary.

weights are hollowed out and contain the springs which oppose the centrifugal force of the weights, the outer ends of the springs being tied by rods passing through the weights themselves. By this means the friction is reduced to a minimum and the levers and pins are freed from all thrust, except such as is required to operate the controlling gear, which of necessity with fine governing must bear a very small relation to the centrifugal force.

The principle of the Whitehead governor is introduced as follows: The spring on one side is divided into 2 unequal portions, the plate forming the piston of the

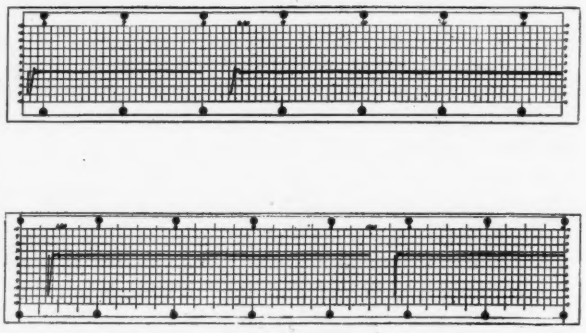


FIG. 4. RECORDS OF SPEED VARIATIONS OF GAS ENGINES

dashpot being interposed between the 2 portions. The dashpot itself is formed in the weight, and is provided with a small adjustable valve, by means of which free communication can be given from the dashpot to the body of the governor. When the bottom casing has been entirely filled and the top portion about 4/5 filled with oil, the governor is ready for work, its action being as follows: If the dashpot valve is wide open so that the oil has a free passage to and from the interior, the dashpot piston is quite free to move and the divided spring behaves as one complete spring, the piston simply acting as a washer. The compound spring in this condition is exactly equivalent to the single spring in the other weight and both are designed exactly to counteract the centrifugal force of the weights in all positions when running at constant speed. Put in another way, the governor is isochronous and if run in this condition it and

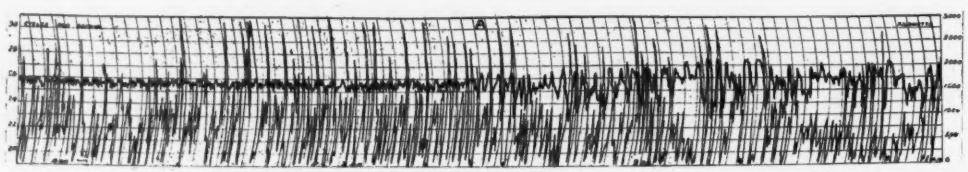


FIG. 3. COMPARISON OF RESULTS OBTAINED FROM AN ORDINARY TYPE OF GOVERNOR AND THE CHORLTON-WHITEHEAD

Figure 2 shows 2 views of the governor in section. At A and A_1 are 2 spindles, which are pivoted in the casting of the center plate. On either end of each is keyed a lever, C and C_1, which carries the governor weights, E and E_1, while in between is keyed a single lever, D, on each spindle, by which the motion of the weights is communicated to the external rod or the external sleeve, as the case may be. The centers of the

the engine would hunt violently, as the governor would have no stability. If, on the other hand, the valve be closed, the dashpot piston becomes immovable, putting the shorter spring out of action. In this way, the effectual length of the spring is decreased and the governor will run with a certain amount, say, 8 per cent, of the variation between inner and outer positions, making the governor stable and in effect too much so for close gov-

erning. If, now, the dashpot valve be partly open, a point can be found where hunting just does not take place, while at the same time, the governor will still be in equilibrium in any position after a certain time has elapsed, allowing the dashpot piston to move to its new place. In other words, the governor will be isochronous subject to a certain time lag, which in practice amounts to about one second. As the control of the engine has been taking place during the whole movement of the weights quite independently of the dashpot, it is only the finish of the movement that is subject to this lag and not the entire movement, as is the case when an external dashpot is attached to an ordinary sensitive governor.

This arrangement can be easily adapted to that compact form of control in which the throttle governor is directly applied to the throttle valve. The Chorlton-Whitehead governor can be mounted on a throttle valve, which may be of the angle or straight-through type. The arrangement can be adapted for belt or chain drive, as required, and with the belt drive the effective arrangement is fitted for shutting off the steam in case of the breakage of the belt. The value of this modern development of the isochronous governor can hardly be overestimated.

Chorlton-Whitehead governors have been applied to both steam and gas engines and steam turbines with some excellent results, a good example being found at the Deptford Power Station of the London Electric Supply Corporation, controlling some massive 3000-hp. compound vertical engines which supply current for the electrified portion of the suburban line of the London, Brighton & South Coast Railway. The load variation on this service amounts to no less than 3000 kw., or considerably more than the power of one engine and it is, therefore, necessary to run at least 2 sets in parallel. The difference in working between ordinary governor control and with the type of governor mentioned above is illustrated in Fig. 3. The record is continuous, taken when the load on 2 of the engines with older governors was transferred at the point A to 2 of the engines fitted with Chorlton-Whitehead governors, the thick line showing the frequency meter record. To give an idea of the nature of the load, the wattmeter record is shown superimposed and it will be noticed that with a change of load of 4500 hp. the momentary variation of speed does not exceed 2 per cent of the mean.

In gas engines the difficulties of governing are not in the engine itself, but in the misfires, which occasionally occur, and the variation in the heat value of the gas, troubles which are inseparable from gas engines running on single producers. Notwithstanding this, the records shown in Fig. 4 are equal to anything which has been produced by any type of reciprocating engine running under similar conditions of load. The top record in this figure refers to a double-cylinder, double-acting engine driving spinning machinery at the Staley Mill Co.'s mills at Staleybridge, while the lower record is from a similar engine driving mules and ring frames, finishing and electrical machinery at Messrs. W. Hollins & Co.'s mill at Nottingham.

California and Mexican Oils

THERE is produced in California and in Mexico an abundance of crude oil containing high percentages of asphalt and sulphur, but relatively small amounts of gasoline and lighter distillates. Hence, these oils have found their principal market as fuel for generation of steam.

In California alone, says A. E. Ballin, a monthly production in excess of 700,000 bbl., was recently made practically useless by the decision of the Standard Oil Co. to purchase no more crude oil below 18 deg. gravity Baume. This rate of production would supply 650,000 hp. of oil engine capacity with fuel running at full load 24 hr. per day continuously. To what extent the economies of water transportation may affect the market for low-grade oil after the Panama Canal is opened, is not now apparent; but that the field will be broadened, there can be no question.

The problem to be solved, if the oil engine is to become a competitor of other forms of prime movers, except in special cases, is, therefore:

To produce an engine which can utilize the low-grade asphalt-base crude oils, and so to design the engine that the ordinary engineer need have no difficulty in maintaining it in satisfactory operation, without requiring frequent or costly repairs.

Arrangements for Exhibits at Panama-Pacific Exposition

EVERY effort is being made by the Panama-Pacific International Exposition to facilitate the entering of an exhibit at the great celebration to be held in San Francisco next year. It is realized by the heads of departments that there must necessarily be a great many details to be attended to by the exhibitor and that many of these add to the expense of displaying. For this reason, the chiefs of departments have instructed their assistants to lend their endeavors in making the entry of exhibits as simple as possible.

The Department of Machinery is not requiring a sketch with application for space, as it is understood that some expense is attached to the making of a sketch and that it might later have to be changed. When all details have been arranged and the amount of space finally allotted to the intending exhibitor, he will then be required to send a sketch showing the placing of his exhibit, but one only will be required. It should be understood that in the Palace of Machinery, from the aisles back to the columns is 33 ft. in the central naves and 31½ ft. in the others. Space should therefore be asked for with one of these figures as one dimension of the desired area.

While the Palace of Machinery is the largest wooden building ever erected, the applications for space already received, if granted, would fill all available space.

The principal value of an exhibit at the Exposition to the exhibitor is the opportunity for advertising and increasing his field of sales. To aid this endeavor, the Department of Machinery is authorizing the exhibitor to take orders directly from the exhibit and fill them at his factory or nearest sales agency.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Electrification of A Steam Railway

ORE-HANDLING ROAD OPERATES FREIGHT AND PASSENGER TRAINS WITH ELECTRIC LOCOMOTIVES USING A LINE VOLTAGE OF 2400

THE Butte, Anaconda & Pacific Railway is, in many ways, the most remarkable example of steam road electrification in this country. Besides being the first 2400-volt, direct-current road, it is also credited with being the first steam road operating both freight and passenger schedules, to electrify its lines purely for reasons of economy.

The first electric locomotives were put in service May 28, 1913, hauling ore cars between the East Anaconda yards and the smelter. During the first 7 months of service, they made approximately 201,000 mi. and hauled about 2,365,000 tons of ore.

Electrified lines of this system extend from the Butte Hill yards to the smelter, a distance of 32 mi. There are numerous sidings, yards, and smelter tracks that have been equipped with overhead trolley, making a total of about 95 mi. on a single track basis.

The Butte, Anaconda & Pacific Railway is essentially an ore-hauling road, the freight traffic from this source originating at the copper mines located near the top of Butte Hill. From the mines, the ore trains are lowered down the mountain a distance of 4½ mi. to the Rocker yards, located a few miles west of the city of Butte.

FIG. 1. INTERIOR OF GENERATING ROOM IN THE RAINBOW STATION OF THE GREAT FALLS POWER CO.

The steam locomotive crews, consisting of engineman and fireman, easily acquired proficiency in handling the electric locomotives; in fact, 2 or 3 days' instructions from a competent electrical man were ordinarily sufficient.

At this point, new main-line trains are made up for transportation to the smelters at Anaconda. The main-line division extends through a rough, mountainous country, a distance of about 20 mi., with grades as high as 0.3 per cent.

At East Anaconda, the main-line trains are broken up and hauled up Smelter Hill to the stock bins, where each car is run over the scales and weighed. The shifting of cars in connection with weighing and subsequent delivery to the concentrators, is done by single locomotives.

The east-bound traffic consists in returning empty cars to the mines and the transportation of copper ingot to the Butte yards, where it is shipped over other roads to refineries.

Between the cities of Butte and Anaconda, which are located at the ends of the electrified portion of the system, there is considerable local traffic, both passenger and freight. The city of Butte and vicinity has a population of about 65,000, and Anaconda about 10,000. At Butte, the Butte, Anaconda & Pacific connects with the Great Northern Ry., the Northern Pacific, and the Chicago, Milwaukee & St. Paul Ry.; and at Silver Bow, about 6 mi. from the city, connection is made with the Oregon Short Line.

The maximum curvature on the system (20 deg., 285 ft. radius) occurs on the Butte Hill line. On this part of the road there is an average curvature of 6 to 10 deg. The locomotives are designed with sufficient flexibility to take a curve of 31 deg. (180 ft. radius) at slow speed.

Power Supply

Energy for the operation of electric trains is purchased from the Great Falls Power Co. The generating plant is located at Great Falls, Mont., on the Missouri River, and has for some time been supplying electric power for the operation of the mines and smelters at Butte and Anaconda. Six hydroelectric units are installed, having a nominal rated capacity of 21,000 kw. The machines are of the horizontal type, generating 6600 volts, 3-phase, at a frequency of 60 cycles. The power is stepped up to 102,000 volts for transmission to the transformer substation at Butte, a distance of 130 mi., over 2 separate parallel lines constructed on the same right-of-way. An extension of the system transmits power at 60,000 volts to a second transformer station at Anaconda, 26 mi. farther on.

The Butte station forms the center of the extensive power system operated by the Montana Power Co. Besides the Great Falls 102,000-volt transmission lines, there are several 60,000-volt transmissions terminating at this point, which form a part of the Montana Power Co.'s system. These lines bring in power from the Hauser Lake, Canyon Ferry, Madison and Big Hole plants. At the Butte substation, this power is stepped down to 2400 volts, 3-phase, and all of these lines are tied in on the 2400-volt, a.c. bus. Ample protection is therefore afforded from interruption of service.

Railway Substations

The 2 existing substations at Butte and Anaconda were used to house the 2400-volt motor-generator sets required for operating the electric trains, so that no additional buildings were constructed for this purpose. Power is furnished by 2 1000-kw., 3-unit motor-generator sets in each substation, taking power from the 2400-volt, a.c. buses. These units operate continuously 24 hr. a day, 7 days of the week, to supply the necessary current for train operation. Each set consists of a 3-phase, 60-cycle, 1450-kv.a., 720-r.p.m., synchronous motor, direct connected to 2 500-kw., 1200-volt generators, insulated to operate in series for 2400 volts. The generators are compound wound and have both commutating poles and compensating pole face windings. These fields are connected on the grounded side of the armature, and the main fields are separately excited from 125-volt exciters.

The 1200-volt generators are provided with heat-proof insulation and, owing to their unusually good commutating characteristics, will carry 3 times normal load for periods of 5 min., as well as the usual 50 per cent overload for 2 hr.

An automatic voltage regulator is used to maintain an approximately constant voltage at the terminals of the motor by power factor regulation. The motors are protected against overload by inverse time limit relays, which are set to open at 4 times normal load. These relays have been adjusted to open under sustained overload in about 2 seconds and upon short circuit their action is practically instantaneous.

Exciters

Excitation for the 2 generating units in each substation is obtained from 2 induction motor driven sets, rated 50 kw. each at 125 volts. One set is used for supplying current to the synchronous motor fields and is controlled by the automatic voltage regulator. The second unit supplies current to the separately excited fields of the direct-current generators.

Switchboards

The 2400-volt switchboards for controlling these sets are the first direct-current boards to be constructed for this high voltage. In general, they are similar to the standard 600-volt types with increased insulation and special provision for interrupting the 2400-volt current. The circuit breakers and switches are also arranged for remote control, and all apparatus on the panels is provided with ample insulation to insure safety to operators.

The 2400-volt circuit breakers and switches are installed on separate panels above and back of the main panels, and are operated by connecting rods from handles mounted on the front of the main switchboard. These handles are similar in appearance; and to avoid confusion, the circuit breaker handles are inverted. The breakers are equipped with special magnetic blowouts and arc chutes, and provision is also made for automatically inserting a high resistance in the generator field at the same instant the main circuit breakers open, thus reducing the generator voltage.

The alternating-current switchboard contains 2 panels for controlling the synchronous motors by means of remote control, solenoid operated oil switches; 2 panels for the motor fields, and a panel for the automatic voltage regulator. These panels also contain other necessary instruments, including frequency and synchronism indicators, ammeters, wattmeters and relays.

Overhead Construction

The overhead construction for this system was especially designed to give the flexibility necessary for satisfactory operation of the pantograph trolleys used on the locomotives. The 4/0 grooved copper trolley used

over all tracks is supported by an 11-point catenary suspension from a stranded steel messenger cable. Both side bracket and cross span construction are used as required by the local conditions. There is a large amount of special work on account of the many yards and sidings, and in one case 12 tracks are spanned. The cross span construction used at this point is supported by a third pole between the 8th and 9th tracks. The hanger used on the straight line construction is a rolled steel strap looped over the messenger wire. This loop is closed at the car and the wire is clamped in place by a single bolt. Special pull-offs are used to increase the flexibility of the suspension.

The section breakers were designed for the 2400-volt service, and at 6 points insulated crossings are necessary at the intersection of the 2400-volt trolley with the 600-volt trolley of the city system. On the main line, a simple section insulator is used. This consists of paralleling the 2 trolley wires from the ends of each section at a suitable distance for insulation so that the pantograph bridges the 2 circuits for a short distance, thus avoiding interruption of the power supply to the locomotive. The construction in the yards and sidings is simplified by paralleling the trolley from the side tracks for a short distance along the main line. This avoids the use of switch plates or similar devices. At some of these junction points the pantograph engages as many as 6 trolley wires.

The overhead lines are protected from lightning by 2400-volt, d.c., type ME arresters, installed on poles at intervals of ⅓ mi., the entire length of the system.

Locomotives

The locomotive equipment consists of 17 80-ton units, 15 for the freight and 2 for passenger service. The freight locomotives are geared for slow speed and are operated in pairs for the main-line service. The maximum free-running speed is 35 m.p.h.

The 2 passenger locomotives are of the same construction as the freight units, but are geared for a maximum free-running speed of 55 m.p.h. A speed of 45 m.p.h. is made with 3 passenger coaches on straight, level track.

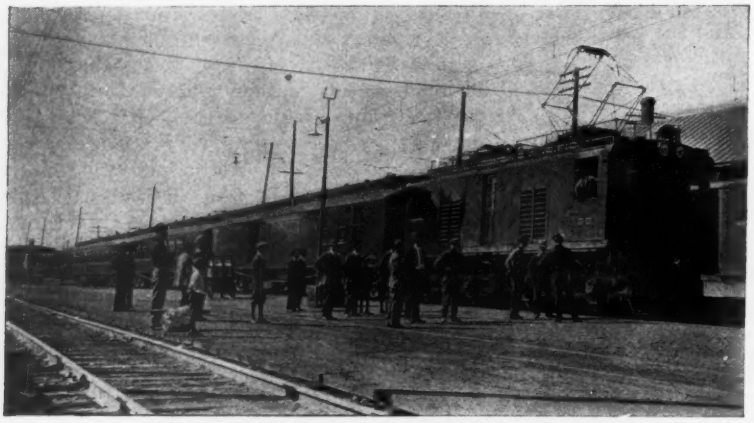


FIG. 2. SINGLE-UNIT ELECTRIC LOCOMOTIVE AND PASSENGER TRAIN AT THE BUTTE SUBSTATION

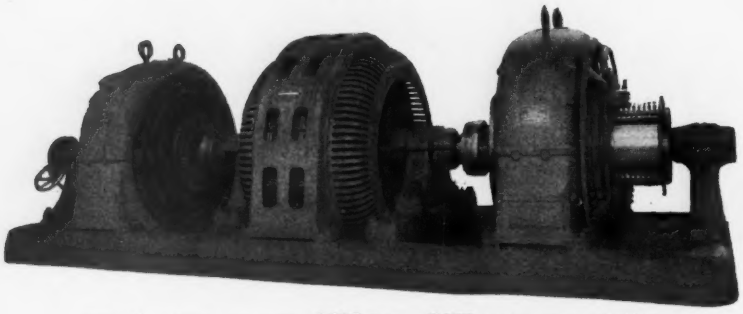


FIG. 3. ONE OF THE 1000-KW., 2400-VOLT, D.C. MOTOR GENERATOR SETS IN THE SUBSTATIONS

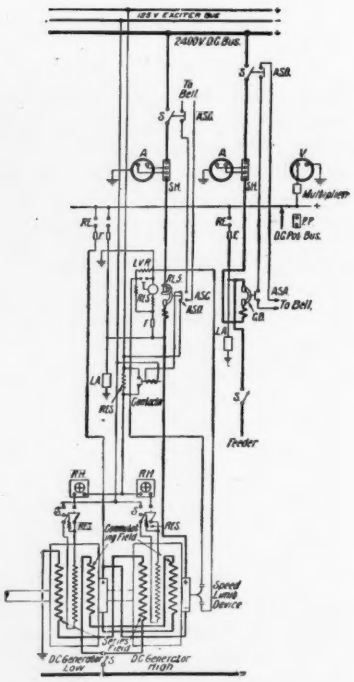


FIG. 4. WIRING DIAGRAM OF SUBSTATIONS

The continuous tractive effort of a single 80-ton freight locomotive is 25,000 lb. at 15 m.p.h. The maximum tractive effort for a period of 5 min. is 48,000 lb., based on a tractive coefficient of 30 per cent.

These locomotives are of the articulated, double-truck type with all the weight on drivers. The cab contains an engineer's compartment at each end, and a central compartment for control apparatus. This cab is of the box type, extending the entire length of the locomotive, and is provided with both end and side doors. The entire weight of the locomotive is carried on semi-elliptic springs suitably equalized.

The motors are of the GE-229-A commutating pole type, wound for 1200 volts and insulated for 2400 volts. This motor was designed for locomotive service and is provided with forced ventilation by the use of an auxiliary blower mounted on an extension of the dynamotor shaft. The control equipment is Sprague-General Electric Type M, multiple unit, operating the 4 motors in series and in series-parallel. Two 1200-volt motors are permanently connected in series. The controller provides 10 steps in series and 9 in series-parallel. The transition between series and series-parallel is effected without opening the motor circuit, and there is no appreciable reduction in tractive effort during the change.

Locomotive Data

The principal data and dimensions applying to the locomotives are the following:

Length inside of knuckles	37 ft. 4 in.
Length over cab	31 ft.
Height over cab	12 ft. 10 in.
Height with trolley down	15 ft. 6 in.
Width over all	10 ft.
Total wheel base	26 ft.
Rigid wheel base	8 ft. 8 in.
Track gage	4 ft. 8½ in.
Total weight	160,000 lb.
Weight per axle	40,000 lb.
Wheels, steel tired	46 in.
Journals	6 in. by 13 in.
Gears, forged rims, freight locomotives	87 teeth
Gears, forged rims, passenger locomotives	80 teeth
Pinions, forged, freight locomotives	18 teeth
Pinions, forged, passenger locomotives	25 teeth
Tractive effort at 30 per cent, coefficient	48,000 lb.
Tractive effort at 1-hr. rating	30,000 lb.
Tractive effort at continuous rating	25,000 lb.

All apparatus for the electrification of this road was furnished by the General Electric Company of Schenectady, N. Y.

Electric Propulsion of the U. S. S. Jupiter

THE U. S. Collier Jupiter, which was built at the Mare Island Navy Yard, and put into commission September 15, 1913, has made a number of trial runs in San Francisco Bay and at sea, but has not yet had her official trials. The Jupiter is a large vessel of about 20,000 tons displacement, and is designed to carry about 12,000 tons of coal and oil. The length of her deck over her cargo space is occupied by a line of derricks, which must add considerably to the weight and wind resistance of the ship.

The Jupiter is equipped with one turbine generating unit and 2 induction motors, one driving each of the propeller shafts. There is also a switchboard carrying switches and instruments.

One feature about the generating unit which is different from the type of units ordinarily used for electrical purposes, is that the governor is so designed that it can be set to hold any desired speed through a wide range, the adjustment of the governor being the normal method of speed variation used in this vessel. The ship can also, if desired, be controlled by the throttle, so that the governor is simply a convenience and in no sense a limitation.

The revolving parts of motors are connected to water-cooled resistances through collector rings; and means are provided by which these collector rings can be short-circuited so that the rotor circuits are closed upon themselves. Such a condition, with the resistances cut out, is the normal state of efficient operation, the resistances being used only for the purpose of giving a large torque in reversing.

During the preliminary runs, the lifting of the propellers to the surface at no time caused any perceptible speed variation. The only effect of such lifting of propellers was a fall of current on the instruments showing a diminution of power delivered to the propellers.

On an unofficial 48-hr. trial, the ship averaged 14.78 knots, the average power delivered by the generator was 5000 kw., corresponding to about 6300 hp. The average revolutions of the propeller were 115. The Cyclops, the sister ship, equipped with 2 triple expansion engines, in her official 48-hr. run made 14.61 knots with an average of 6705 indicated horsepower.

Results of these preliminary runs would indicate that the equipment in the Collier Jupiter is more economical; and can be controlled more readily than any former arrangement in ships of the same displacement and speed.

As an example of what may be accomplished in raising the power factor by the use of synchronous motors on an induction motor line, F. M. Farwell, in the Electrical World, gives an account of a steel-works load, where the motors were used for driving a rolling mill. By using synchronous motor generators to give direct current where necessary, and synchronous motors where the load conditions would justify, with an induction motor load about ⅔ the synchronous motor load and an electric furnace taking about double the synchronous motor load, it was found that with the induction motor load alone, the power factor at the station would be between 65 and 70 per cent. With the furnace added, it would go up to from 75 to 80 per cent, and with the further addition of the synchronous motor load, the power factor would rise to 92 or 93 per cent. When the electric furnace was dropped, the power factor would reach approximate unity.

Figures just issued by the department of commerce show progress made by the central electric light and power stations of Iowa. Gains are reported during the decade 1902-1912. The number of establishments increased from 169 to 223, or 32 per cent, and the income amounted to $4,344,786 in 1912 as compared with $1,545,663 in 1902, or an increase of 181 per cent. The total horsepower developed by all engines was 70,102 in 1902 as compared with 37,105 in 1912, and of which amount water wheels developed 2399 in 1902 to 7029 in 1912, or an increase of 193 per cent. The output of stations in 1912 amounted to 67,166,647 kw.-hr. against 36,506,425 in 1902. The total expense was $3,328,740 in 1912 and $1,223,682 in 1902.

Raising A Stack

ERECTING A 90-FT. STEEL STACK WITH A 35-FT. GIN POLE AND 3 MEN, AND SETTING IT ON A 10-FT. PEDESTAL. BY JOHN PIERCE

IN reading through the Dec. 1 issue, I found a clever article by Geo. H. Wallace, regarding the "how" to raise a stack. The reading of his article brings to mind a job of stack-raising which I had some years ago. To start in on the job I had several men help me raise the pole, but as these were merely men who were, at the time, passing by and whom I waylaid, they stayed only long enough to get the pole into place. After their leaving, I had but 2 men to help. One of these was a lineman, and one was a good-sized fellow who had never had any experience except driving a horse, and therefore, outside of his great strength, was not of much use to me. The stack was 95 ft. in length, and 36 in. in diameter, and had to be raised to set on top of a pedestal 10 ft. high. I had a 35-ft. pole to raise it with.

Now, as I read Mr. Wallace's plan, using a pole ¾ the length of the stack, I must confess that I had

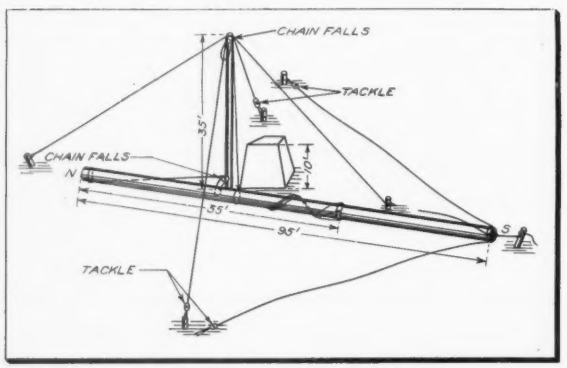


FIG. 1. FIRST STEP IN RAISING STACK

almost rather raise the stack than to have used a pole ¾ the length of the stack with which I was working. I made my pole fast with fixed guys on 2 opposite sides, in this case being the north and the south sides. For the guys running east and west I made each fast with a set of blocks for ½-in. rope and poles. You see I realized that it was a big job for such a small crew of us, and now that it is done, years ago (and the stack still stands), why, I'm free to confess that I was much in doubt about our getting it up. Yet I would not have admitted it then, for I had made up my mind that this stack was going to be raised, and that we were going to be the ones who did the job.

With a heavy pair of blocks I pulled the stack (lying north and south) along the ground until 35 ft. of it lay on one side of the pole, and 60 ft. on the other side. I then removed my hitch, and the lineman and I, after putting on our "hooks," went up the pole and made fast a heavy set of chain blocks. To the bottom of the pole we made fast another set of lighter chain blocks, and then threaded our stack guys in the top of the stack, and a set at the 60-ft. point, also. These last we wrapped around the stack so as to be out of our way, and the top ones we laid out long enough so that we could snub them to our anchors after the stack began to get up. After we had lifted the stack some little distance, we also made the east and west stack guys fast with block and tackle, while the south one was merely snubbed to an anchor. Later, when the top began to take a more perpendicular position, we blocked with a heavy block and tackle to the north guy.

After these little details had all been arranged, my lineman went up the pole, made fast his safety belt, and went to hoisting. My husky man pulled on the chain blocks running from the bottom of the pole to the bottom of the stack, while I went from anchor to anchor, slacking off a little here, and tightening a little there.

Finally, we had the stack in such a position, having drawn in the bottom at the same time as we raised it bodily, that it gave the blocks on the north guy a chance to take hold, and from then on we had no difficulty in pulling it straight up, its bottom resting on the ground at the side of the pole. Taking a new hitch,

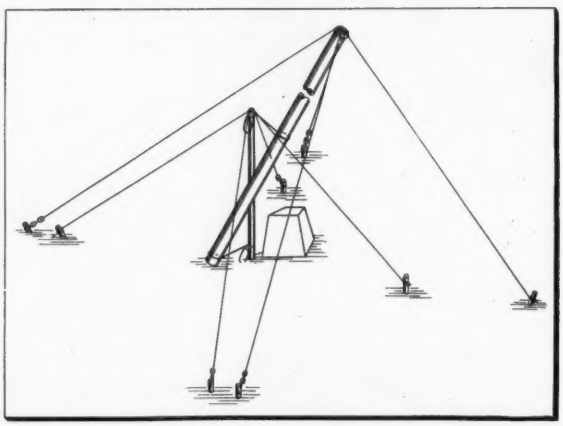


FIG. 2. PAST THE CRITICAL POINT IN RAISING THE STACK

about 10 ft. from the ground, with the heavy chain blocks at the top of the pole, we pulled the stack straight up in the air, being very careful with our guys in the meantime.

The stack being thus raised to a point slightly above the top of the pedestal, one of us loosened the west pole guy, while the east one was tightened, leaning the pole until the stack was directly over its plate, and then lowering it into place. We then made our guys permanent, and the job was done.

We thus (aided for ½ hr. by several others, and with the help of a number of chain blocks and rope tackle) raised this stack in 8 hr., which, I have always been vain enough to feel, was a good job in a remarkably short time.

WORK HAS BEGUN in Green Forest in Carrol County, Ark., on the building of the plant of the Green Forest Electric Light and Power Co., which is expected to be ready to furnish light by May. The plant will cost $10,000, and according to L. H. Smith of Green Forest, will use the newest of general electric type apparatus.

Calculations of Boiler Test

FORMULAS USED, SUBSTITUTIONS MADE, EXPLANATION OF CONSTANTS

REQUESTS frequently come from readers of Practical Engineer for directions for calculating the various items which are necessarily part of a report of a boiler test. The calculations for the various items of the code of the A. S. M. E., which are not obtained by direct observation are, therefore, given herewith, and were included as part of the report of the tests of 4-pass boilers at the National Tube Co.'s plant in Kewanee, Ill., which was published in the Feb. 15 issue. The figures used in these calculations were secured during test No. 5 and are representative of the entire series of tests conducted on these boilers.

In Item 19 it will be noted that several corrections are made in order to secure the correct weight of water fed to the boiler. Unfortunately, perfect conditions for a complete boiler test practically never exist, so it is necessary for the engineer in charge to estimate the effects of the undesirable conditions and incorporate the corrections in his report, as is done here.

Item 16. Total weight of dry coal consumed

$$= \text{wt. of coal as fired} \left(1 - \frac{\text{percentage moisture in coal as fired}}{100}\right)$$
$$= 82569\left(1 - \frac{14.08}{100}\right)$$
$$= 70943 \text{ lbs.}$$

Item 17. Total ash and refuse

$$= \frac{\text{total dry coal} \times \text{percentage ash in dry coal}}{100 - \text{percentage combustible in dry ash}}$$
$$= \frac{70943 \times 21.77}{100 - 11.01}$$
$$= 17355 \text{ lbs.}$$

Item 18. Percentage of ash and refuse in dry coal

$$= 100 \times \frac{\text{total ash and refuse}}{\text{total dry coal}}$$
$$= 100 \times \frac{17355}{70943}$$
$$= 24.48 \text{ per cent.}$$

Item 19. Total weight of water fed to boiler

Total water weighed	580,895
Correction for gland leakage	−2400
Correction for rise in water level (3/8 in. @ 960 lbs. per in.)	−600

Correction for heating excess water

$$= \text{lbs. excess water} \times \frac{\text{heat of liquid at final pres.} - \text{Av. heat of feed water}}{\text{Av. total heat of steam} - \text{Av. heat of feed water}}$$
$$= 600 \times \frac{319.9 - 151.8}{1089.9} = \quad +93$$

Correction for change in pressure = lbs. water in boiler at start ×

$$\frac{\text{heat of liquid at final pressure} - \text{heat of liquid at original pressure}}{\text{Av. heat added per lb water}}$$
$$= 65000 \times \frac{3.7}{1089.9} = \quad +220$$

Correction for pops

$$= \frac{\text{discharge cap. of safety valve}}{2} \times \frac{\text{total minutes of pop}}{60} \times \frac{\text{Av. total heat of steam} - \text{total heat of saturated steam at Av. pop pres.}}{\text{Av. heat added per lb water}}$$
$$= \frac{8230}{2} \times \frac{50}{60} \times \frac{1241.7 - 1191.7}{1089.9} = \quad -158$$

Total corrected weight of water fed to boiler
$= 580{,}895 - 2400 - 600 + 93 + 220 - 158 = 578{,}050$ lbs.

Item 20. Same as Item 19 for superheated steam.

Item 21. Total equivalent evaporation from and at 212°

$$= \text{total wt. of water fed to boiler} \times \frac{\text{Av. total heat of steam} - \text{Av. heat of feed water}}{970.4}$$
$$= 578{,}050 \times \frac{1241.7 - 151.8}{970.4}$$
$$= 649{,}208 \text{ lbs.}$$

Item 22. Dry coal consumed per hour

$$= \frac{\text{total dry coal consumed}}{\text{length of test}}$$
$$= \frac{70943}{24}$$
$$= 2956.$$

Item 23. Dry coal consumed per sq. ft. of grate surface per hour

$$= \frac{\text{dry coal consumed per hour}}{\text{grate surface}}$$
$$= \frac{2956}{91}$$
$$= 32.5.$$

Item 24. Water evaporated per hour

$$= \frac{\text{total water fed to boiler}}{\text{length of test}}$$
$$= \frac{578{,}050}{24}$$
$$= 24085.$$

Item 25. Equivalent evaporation per hour from and at 212°

$$= \frac{\text{total equivalent evap. from and at 212°}}{\text{length of test}}$$
$$= \frac{649{,}208}{24}$$
$$= 27050.$$

Item 26. Equivalent evaporation per hour from and at 212° per sq. ft. of water heating surface

$$= \frac{\text{equivalent evaporation per hour from and at 212°}}{\text{total sq. ft. of water heating surface}}$$
$$= \frac{27050}{7332}$$
$$= 3.69.$$

Item 27. Same as Item 25.

Item 28. Boiler horsepower developed

$$= \frac{\text{equivalent evaporation per hour from and at 212°}}{34.5}$$
$$= \frac{27050}{34.5}$$
$$= 784.1$$

Item 29. Rated capacity in evaporation from and at 212°

$$= \text{rated boiler horsepower} \times 34.5$$
$$= 613.2 \times 34.5$$
$$= 21155.$$

Item 31. Percentage of rated capacity developed

$$= 100 \times \frac{\text{boiler horsepower developed}}{\text{rated boiler horsepower}}$$
$$= 100 \times \frac{784.1}{613.2}$$
$$= 127.9 \text{ per cent}$$

Item 32. Water fed per lb of coal fired

$$= \frac{\text{total water fed to boiler}}{\text{total coal fired}}$$
$$= \frac{578{,}050}{82569}$$
$$= 7.001.$$

Item 33. Water evaporated per lb of dry coal

$$= \frac{\text{total water fed to boiler}}{\text{total dry coal consumed}}$$
$$= \frac{578{,}050}{70943}$$
$$= 8.148.$$

Item 34. Equivalent evaporation per lb of dry coal

$$= \frac{\text{total equivalent evaporation from and at 212°}}{\text{total dry coal consumed}}$$
$$= \frac{649{,}208}{70943}$$
$$= 9.151.$$

Item 35. Equivalent evaporation per lb of combustible burned

$$= \frac{\text{total equivalent evaporation from and at 212°}}{\text{total dry coal consumed} - \text{total ash and refuse}}$$
$$= \frac{649{,}208}{70943 - 17355}$$
$$= 12.115.$$

Item 37. Calorific value of 1 lb of combustible

$$= \frac{\text{calorific value of 1 lb. dry coal}}{\left(1 - \frac{\text{percentage ash in dry coal}}{100}\right)}$$
$$= \frac{11048}{1 - \frac{21.77}{100}} = 14123 \text{ B. T. U.}$$

Item 38. Efficiency of boiler, furnace and grate

$$= 100 \times \frac{\text{equivalent evaporation per lb of dry coal} \times 970.4}{\text{calorific value of 1 lb of dry coal}}$$
$$= 100 \times \frac{9.151 \times 970.4}{11048}$$
$$= 80.38 \text{ per cent.}$$

Item numbers refer to Short Code, as recommended by A. S. M. E.

In Item 21 the figure 970.4 is the latent heat of steam at atmospheric pressure. The pounds of water evaporated from and at 212 deg. F, to secure one boiler horsepower, according to the centennial rating, is 34.5. This figure is used in Item 28.

Item 95. Heat absorbed by boiler
$$= \text{equivalent evap. per lb dry coal} \times 970.4$$
$$= 9.151 \times 970.4$$
$$= 8880.$$

Item 96. Loss due to evaporation of moisture in coal
$$= \frac{\text{percentage moisture in coal}}{100 - \text{percentage moisture in coal}} \times \left(\begin{matrix}\text{B. T. U. added per lb water from room} \\ \text{temperature to stack temperature}\end{matrix}\right.$$
$$= \frac{14.08}{85.92} \times 1221$$
$$= 200.$$

Item 97. Loss due to heat carried away by steam formed by burning of hydrogen
$$= 9 \times \frac{\text{percentage hydrogen in dry coal}}{100} \times \left(\begin{matrix}\text{B. T. U. added per lb water from room} \\ \text{temperature to stack temperature}\end{matrix}\right.$$
$$= 9 \times \frac{4.67}{100} \times 1221$$
$$= 513.$$

Item 98. Loss due to heat carried away in dry flue gases
$$= \text{lbs. dry flue gas per lb of carbon burned} \times \frac{\text{carbon burned}}{\text{dry coal}} \times \left(\begin{matrix}\text{rise in temp.} \\ \text{of gases}\end{matrix}\right) \times \text{specific heat of gases}$$
$$= \frac{11CO_2 + 8O_2 + 7(CO + N_2)}{3\,(CO_2 + CO)} \times \frac{\left(\begin{matrix}\text{percentage car-} \\ \text{bon in dry coal}\end{matrix}\right) - \left(\begin{matrix}\text{percentage ash and} \\ \text{refuse in dry coal}\end{matrix} - \begin{matrix}\text{percentage ash} \\ \text{in dry coal}\end{matrix}\right)}{100} \times \left(\begin{matrix}\text{stack temp.} - \\ \text{room temp.}\end{matrix}\right) \times .24$$
$$= \frac{11 \times 13.03 + 8 \times 5.62 + 7 \times 81.35}{3\,(13.03 + .03)} \times \frac{58.65 - (24.48 - 21.77)}{100} \times (450 - 75) \times .24$$
$$= 19.32 \times .5594 \times 375 \times .24$$
$$= 973 \text{ B. T. U.}$$

Item 99. Loss due to carbon monoxide
$$= \frac{CO}{CO_2 + CO} \times \frac{\text{carbon burned}}{\text{dry coal}} \times 10150$$
$$= \frac{.03}{(13.03 + .03)} \times 5594 \text{ (from Item 98)} \times 10150$$
$$= 13 \text{ B. T. U.}$$

Item 100. Loss due to combustible in ash and refuse
$$= \frac{\text{percentage ash and refuse in dry coal} - \text{percentage ash in dry coal} \times 14600}{100}$$
$$= \frac{24\ 48 - 21.77}{100} \times 14600$$
$$= 396 \text{ B. T U}$$

Item 101. Losses due to heating moisture in air, unconsumed hydrogen, hydro-carbon, radiation, and unaccounted for = difference between total heat per lb of dry coal and heat accounted for per lb dry coal.
$$= 11048 - (8880 + 200 + 513 + 973 + 13 + 396) = 73 \text{ B. T. U}$$

Item numbers refer to Complete Code as recommended by the A. S. M. E.

Lbs. air per lb dry coal.
$$= \frac{3.032N}{CO_2 + CO} \times \frac{\text{carbon burned}}{\text{dry coal}}$$
$$= \frac{3.032N}{13.03 + .03} \times 5594 \text{ (from Item 98).}$$
$$= 10.57.$$

By burning 1 lb. of carbon contained in carbon monoxide to carbon dioxide, the heat developed is 10,150 B.t.u. This figure is used in Item 99. 14,600 is the B.t.u. developed by burning 1 lb. of combustible to CO_2.

All other figures used were taken from the test observations.

THE GOVERNMENT of the Province of Mendoza has approved the project presented by the Empresa de Luz y Fuerza for a hydroelectric station on the River Mendoza. The dam is to be built 1 kilometer above Cacheuta station, and there will be a tunnel of 2200 meters in length to the turbine station. Instead of the construction of a retaining wall, a steel cylindrical dock will be used; this will be 25 meters in length by 4 in diameter. The tunnel will have a capacity for 30 cubic meters per second. There will be 4 turbines of 4000 hp. each. The cost of the work is estimated at $7,000,000 (national currency).

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Experiments With Natural Gas Engine

EFFECTS OF CHANGES IN MIXTURE AND POINT OF IGNITION. BY W. G. WEBSTER

THE engine is single-cylinder, horizontal, single-acting, 4-stroke cycle, with a hit-and-miss governor arrangement and auxiliary exhaust, and operates on natural gas. The cylinder bore is 10½ in. and the stroke is 15 in.; the igniter is of the make-and-break type, mechanically operated.

The cards were taken on a Trill indicator, using a ¼-sq. in. piston and a 60-lb. spring. The engine was not used for any other purpose, and its only load was obtained by braking the flywheel with a 4 by 4-in. oak scantling.

Card No. 1 is a fair card, but shows that the igni-

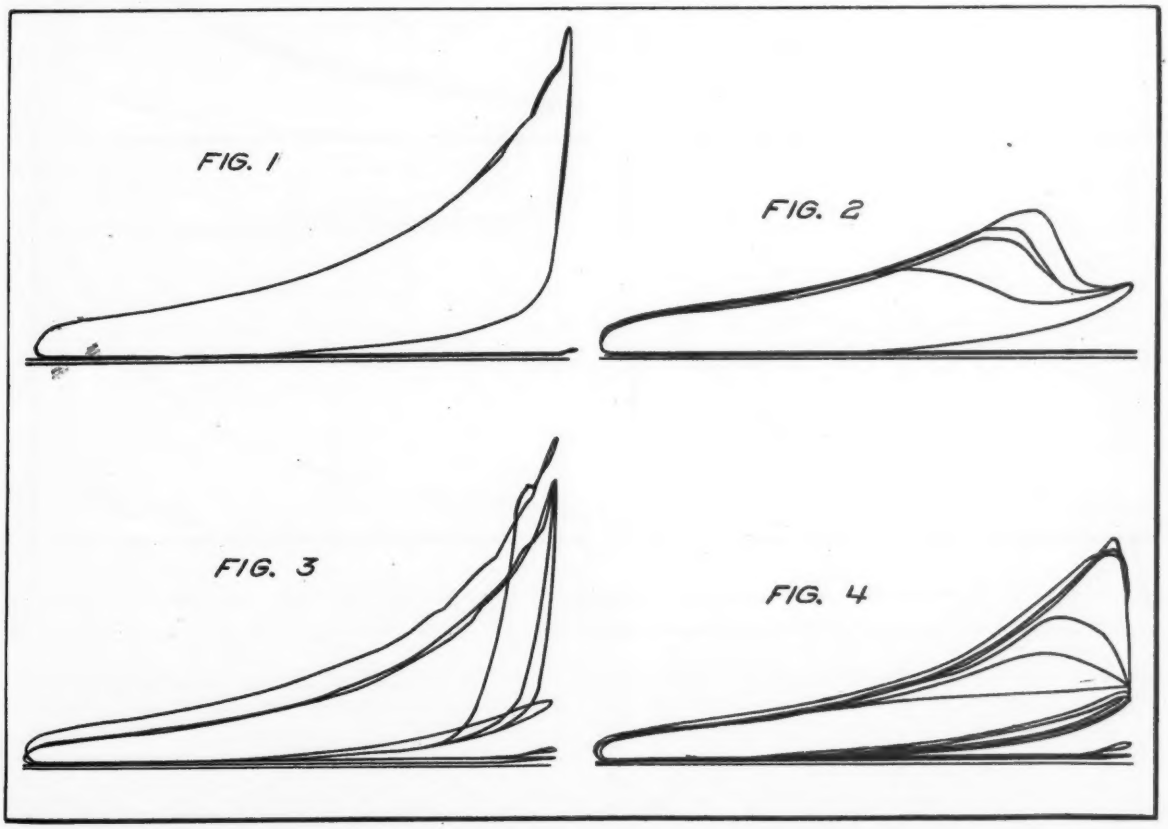


FIG. 1. CARD SHOWING EARLY IGNITION
FIG. 3. EFFECT OF EXTREMELY EARLY IGNITION

FIG. 2. EFFECT ON CARD OF LATE IGNITION
FIG. 4. CARDS TAKEN WHILE GRADUALLY WEAKENING THE MIXTURE, IGNITION POINT REMAINING THE SAME

After reading several conflicting articles on what causes the wavy expansion line found on so many gas-engine cards, the writer obtained the accompanying cards. The reducing motion used, gives very closely the correct motion; the error is slight and is of no consequence.

tion was a trifle early, and the engine bumped or pounded at time of ignition. The compression is 67 lb. and the initial pressure is 296, or a ratio of expansion compression of 4.04 times, which is a good average; the release pressure is 30 lb., which is fair.

Next, card No. 2 was taken, showing the greatly

reduced mean effective pressure, and that with late ignition, a greatly reduced amount of power is derived from the same quantity of gas.

Card No. 3 shows the effect of very early ignition, and shows that the engine is practically working against itself, and that early ignition is as bad or worse than late ignition. This card shows that the engine did not fire in one cycle, although the charge seems to have partly ignited, as the expansion line is slightly higher than the compression.

Card No. 4 shows the effect of gradually weakening the mixture, while the ignition remained unchanged; this proves that the time of ignition must be advanced as the mixture weakens.

opened suddenly and the engine came up to speed. This card shows that the ignition must be advanced as the engine speed increases.

The higher pressures are taken at the lowest speeds while, as the engine speeds up, the card becomes less ideal and shows that the ignition is very late. It will be noticed that the compression is the same for all speeds.

Card No. 7 was taken with a mixture containing just enough gas to fire regularly at every cycle; it is a fair card and is high in mean effective pressure, low in initial pressure, and the engine ran very smoothly. There did not seem to be any shock at time of ignition.

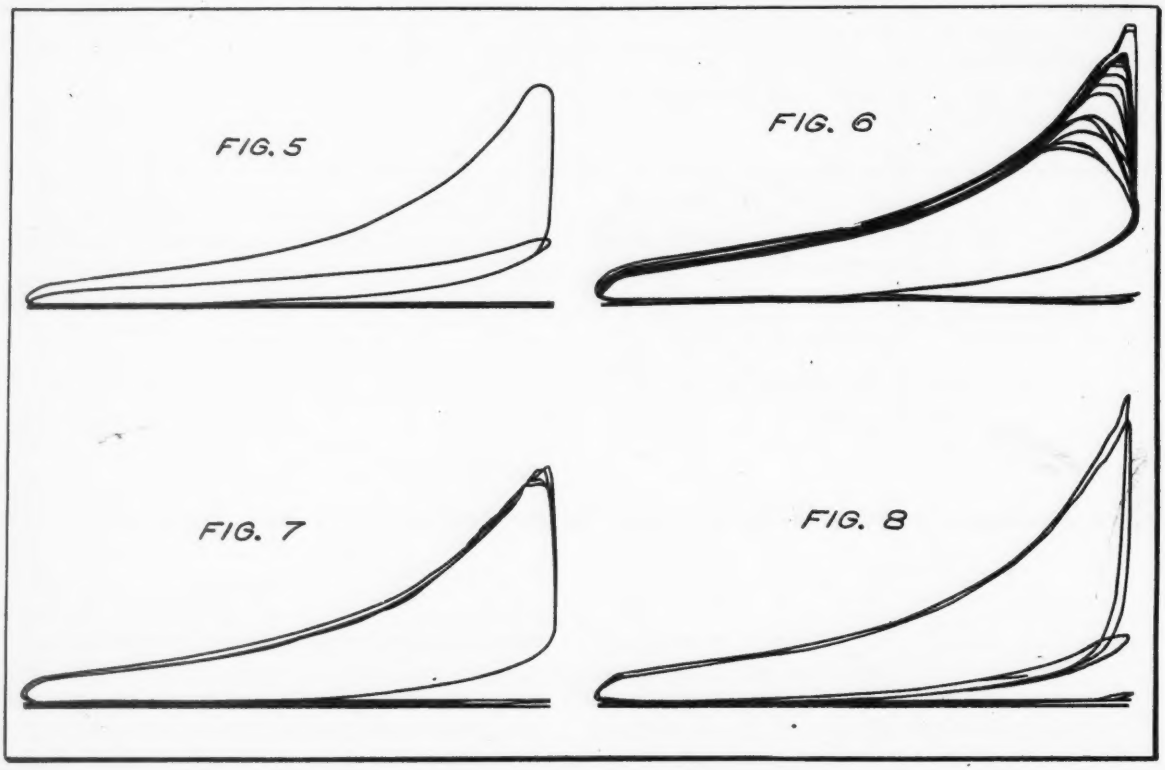


FIG. 5. EXTREMELY WEAK MIXTURE AND EARLY IGNITION

FIG. 6. EFFECTS OF VARYING SPEED OF GAS ENGINE

FIG. 7. CARD TAKEN WHEN MIXTURE WAS JUST SUFFICIENT TO CAUSE REGULAR FIRING

FIG. 8. WEAKER MIXTURE AND EARLIER IGNITION THAN NO. 7 GAVE THIS CARD

While card No. 5 was being taken, the mixture was so weak that the engine seemed to be firing every other cycle, but it actually ignited every cycle, the mixture being so weak that it had to scavenge itself before the weak charge could be fired properly. This proves the necessity of scavenging or cleaning the cylinder of as much of the exhaust gases as possible.

Particular attention should be paid to the slow flame propagation, and that higher mean effective pressure is obtained without such high initial pressures; also, that the pressure at the point of release is lower.

Card No. 6 was taken by first letting the engine slow down, and when at about 35 r.p.m., the gas cock was

Card No. 8 was taken with slightly less gas in the mixture than was used in card No. 7. This card shows 70 lb. m.e.p.; also, that there are 2 cycles with power and one with no power. The conclusion I came to, was that the card represented by the highest initial pressure is the first power cycle; that, the mixture being weak, the next charge is more diluted with exhaust gases and a lower initial pressure is obtained; also, the charge does not seem to ignite as soon as the first one. Then the next charge is so much weakened by the exhaust gases that it seemingly ignites and goes out. Since there are no burned gases in this cycle, in the next or fourth, the cylinder is clean and the charge fires easily.

Card No. 9 was taken with a ½-in. area piston and a 60-lb. spring, to find out with a greater degree of accuracy the exact compression. This card was taken while the engine was running about 250 r.p.m.; the gas was turned on, but the switch to the ignition was open. It shows that the charge ignited itself, as expansion line, A, shows. The next cycle, the expansion line, B, shows that the charge ignited, but burned more slowly. The third cycle charge ignited, but did not burn, as is shown by expansion line, C. The compression was the same—67 lb. for each cycle.

The pressure in the cylinder rises considerably during the exhaust stroke, and does not drop so quickly as it should, for the inlet valve opens at this point.

Card No. 10 is a stop diagram, taken with a ½-in. area piston and a 12-lb. spring. Starting with the release line, it shows that the pressure drops almost back-fire through the admission valve. By closely following the lines on this card, we find that the release line is regular and that after the regular cycle there was a charge that did not ignite, and the expansion line, A, of this charge, falls below the atmospheric line and ignited while the exhaust ports were open, the piston covering these up, the pressure rapidly rises until the end of the exhaust stroke, when the inlet valve opens with a pressure in the cylinder of 18 lb., which is released through the inlet valve, causing a so-called back-fire.

I was unable to get a card with a wavy expansion line after 3 hr. of changing mixture, ignition, etc.; but on other engines, with higher compression, I find that a rich mixture will cause the wavy line.

I will state further, that the engine these cards are taken from exhausts through 7 or 8 ft. of 4-in. pipe,

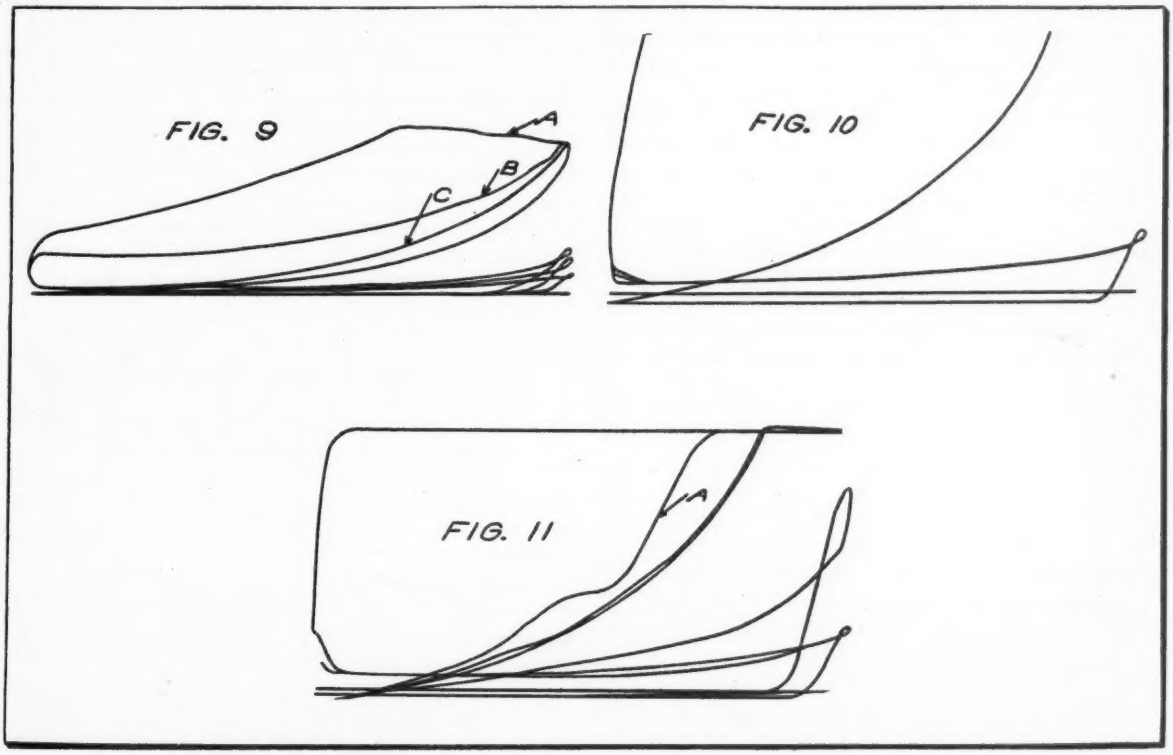


FIG. 9. CARD TAKEN TO SECURE MORE ACCURATE COMPRESSION LINE

FIG. 10. STOP DIAGRAM OF BACK AND SUCTION PRESSURES

FIG. 11. EFFECT OF SO-CALLED BACK-FIRING

instantly to 1 lb. above the atmosphere, gradually rising to 5½ lb. at the extreme end of the exhaust stroke, where it loops back and drops rather slowly to ¾ lb. below atmosphere. The induction line remains straight throughout. The inlet valve closes on dead center, and the compression commences. This card shows that the inlet valve opens at the proper time, that the exhaust pipe is long and that it takes considerable pressure to push the gases through it.

Card No. 11 was taken with the same piston, and spring as No. 10, and is a valuable card, as it shows the pressures set up in the cylinder by so-called

into a cast-iron muffler; that the cooling water is put into the exhaust pipe before it enters the muffler, and that there is about 50 ft. of 4-in. pipe from muffler to end of pipe. We use considerable water in the engine jacket; there is very little noise, and no steam comes from the exhaust pipe, showing that the water in the muffler and pipe causes the high pressures at the end of the exhaust stroke.

Although I failed to find what caused the wavy lines, I am not discouraged, as I have found the why and wherefore of several other things concerning indicator diagrams from gas engines.

Gas Engine Operation*

PRACTICAL POINTS MET IN OPERATION; NEED OF COMPETENT SUPERVISION

EXCEPT for marine work, the 4-cycle gas engine is used almost exclusively rather than the 2-cycle type, on account of the higher efficiency of the former. This is due largely to difficulty in obtaining sufficient crank-case compression and the lack of effective scavenging in the 2-cycle type. Better results are secured with a scavenging and a charging pump but, of course, the power required to operate these is a total loss. The 2-cycle engines used in marine work generally do not exceed 30 to 40 b.hp. and a thermal efficiency above 15 per cent is seldom attained, while with the 4-cycle type an efficiency of 25 to 30 per cent is not uncommon. The ordinary 2-cycle type is nonflexible for load changes, since with a reduction in the crank case compression, a considerable part of the charge is apt to escape through the exhaust ports, leaving a large quantity of burned gases in the cylinder. The advantages of the 2-cycle engine are due to the fact that 1 power stroke is secured for each revolution, and, consequently, a smaller flywheel suffices. An added advantage is the absence of inlet and exhaust valves.

Gas engines of the 4-cycle vertical type are frequently built with 3 cylinders in the larger sizes, which seldom exceed about 300 b.hp., although much larger units have been built. The best efficiency with gas engines is obtained at from 75 to 100 per cent of full load, and at light load the economy drops off rapidly. A consumption of 9.5 cu. ft. of natural gas per b.hp.-hr., including auxiliaries, is sometimes reached, but is rather exceptional.

Of the various systems of governing, a combination of the quality and quantity methods probably gives the best results. With this method the gas is throttled and the compression remains constant from full to half load. Below half load both air and gas are throttled, reducing the compression with the load. The ignition is also automatically advanced as the mixture is weakened.

One of the important details in gas engine construction is the proper clearance between cylinder wall and piston. With a single-acting piston, a great deal more clearance is required at the head end than at the crank end of the piston, on account of the direct contact of the head end with the hot gases. In a 200-hp. engine, the proper clearance was found to be about 0.006 in. to within 3 in. of the crank end and about 0.03 in. at the head end of the piston. Another difficulty is the unequal expansion between the cylinder and jacket wall. In the larger horizontal engines it is necessary to make the jacket in 2 separate parts and provide a slip joint on account of this unequal expansion.

The presence of a large percentage of hydrogen is often a source of much trouble because it often results in pre-ignition. In some engines the incoming charge comes into contact with a water-cooled projection extending into the clearance space of the cylinder. Where the gas is cooled in this manner there is less liability of pre-ignition.

For various fuels the following compression pressures have been found to give best results:

Producer gas	125 to 150 lb.
Blast furnace gas	130 to 200 lb.
Illuminating gas	70 to 120 lb.
Natural gas	70 to 110 lb.
Gasoline	60 to 80 lb.

depending on the speed.

To secure good lubrication a pure mineral oil is required, which will stand a fire test of 500 to 550 deg. F. The discharge temperature of the jacket water is ordinarily kept at about 130 to 140 deg. F., as a higher temperature often results in pre-ignition and poor lubrication. Sometimes with a gas high in hydrogen it is found necessary to keep the discharge temperature down as low as 90 deg.

While the gas engine can not be said to be so reliable as the steam engine, good results are possible with the former if properly understood and carefully handled. The author of the paper has charge of a 100-hp. 3-cylinder vertical engine, direct connected to a direct-current generator, which ran continuously 24 hr. a day for more than 90 days.

It used to be the custom of gas engine manufacturers to advertise their engines as requiring little attention after starting, but this practice has been abandoned on account of the gas plant failures traceable to the lack of proper supervision by competent operating men. What is true as to the skill and training required in the successful operation of a steam plant, applies fully as well to the gas plant.

*Notes from an illustrated lecture by O. T. Meissner before N. A. S. E., No. 1, Chicago.

Uehling Triple Draft Gage

THE ordinary draft gage shows the drop of pressure between the boiler room and the damper. This information, though not without value, is quite insufficient to serve as aid to the fireman to control his fires properly. Draft so measured has 3 distinct components.

First, the drop of pressure from the boiler room to the ash pit. This may be negligible if the ash pit doors are wide open, or it may be considerable if they are partially or nearly closed.

Second, the furnace draft, i. e., the drop of pressure between the ash pit and the furnace, which represents the resistance through the fire. This factor varies, *a* with kind of fuel, *b* with the physical condition of the fuel, *c* the thickness of the fuel bed, *d* the condition of the fuel bed, i. e., the evenness of fire, *e* the thickness of the ash bed, *f* the physical condition of the ash bed, contents of slate, clinker, etc., *g* construction and condition of the grate, *h* the condition of the grate.

Third, the boiler draft, that is, the drop of pressure between the furnace and the damper. This depends upon the type of boiler, the manner of setting, baffling, etc., but in any given boiler varies only with the volume of gas passing through, i. e., the rate of driving.

Total draft is the force which induces combustion; but since its effectiveness depends on so many continually changing conditions, its indication can neither serve as a measure of the rate of combustion nor as an aid in the proper control of the fire unless analyzed into the

several factors composing it. This is accomplished by the Uehling triple draft gage herewith illustrated.

It consists of a deep metal box frame with a wide scale attached to the bottom. Attached in front of this scale in an inclined position is a large glass tube LL containing a small tube, H, which protrudes from LL at its upper end. H and L respectively are in communication with the 5-way valve C through the connections D and K. Valve C is further connected through suitable pipes A with the ash pit, I with the furnace and G with gas exit between the boiler and the damper. The valve C is operated by a movable index J which revolves in front of a dial upon which the letters O, T, F, B are shown. When index points to O, H and L are in communication and the gage shows zero. When it is moved to T, H and L are in communication respectively with A and G, and the gage shows the total draft, i.e., the drop of pressure between the ash pit and damper. When the index is moved to F, H and L respectively communicate with A and I and the gage shows the furnace draft, i. e., the drop of pressure or resistance through the fire. If the index is moved to B, H and L respectively communicate with I and G and the gage shows the boiler draft, i. e., the drop of pressure between the furnace and the damper.

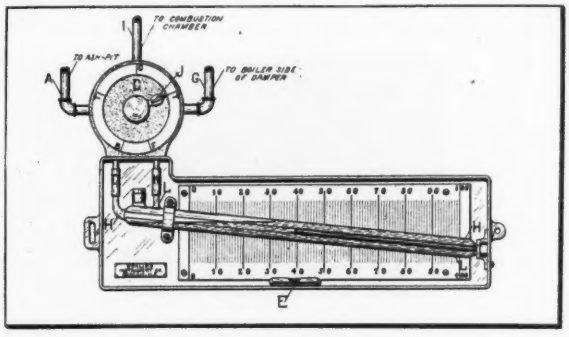


DIAGRAM OF THE UEHLING TRIPLE DRAFT GAGE

Thus by the aid of the Uehling draft gage, the draft can be analyzed at any moment and the true conditions ascertained. This information will materially aid any intelligent fireman in getting good results.

This gage is equally applicable to boilers served with forced or induced draft, as to those depending on natural draft, because it measures the resistance through the fire and the boiler, separately or collectively as desired, irrespective of the pressure in the ash pit.

The boiler draft is a measure of the volume of gas passing through the boiler, hence an index to the rate of driving. With the aid of this gage the fireman can always see whether he is driving his boilers at the proper rate.

To know whether he is running efficiently he must have a CO_2 indicator as well. The per cent of CO_2 is the only true guide to economical firing.

The Uehling Instrument Co., Passaic, New Jersey, is the manufacturer of this instrument.

Teaching Boiler Operation

HARRINGTON & PEEBLES have consummated an arrangement with the Illinois Traction System, whereby they are to establish a school of instruction at the Peoria plant for the benefit of the superintendents, engineers and boiler-room foremen of the system.

Mr. Harrington started this work immediately after the holidays. His plan is to equip one boiler at this plant with a full set of both indicating and recording instruments to show and record all of the draft and temperature changes that take place with different methods of firing. Both coal and water will be continuously measured and a test of considerable refinement can be deducted at a moment's notice. It is planned to have diagrams of the boiler on a large scale whereon actual draft instruments are placed, so that the draft changes throughout the entire boiler can be observed at a glance and the effect of damper and fuel bed changes immediately noted.

It is planned to have the following recording instruments installed: A recording venturi meter; a coal weigher; a recording steam flow meter; a recording gas-analysis instrument; recording thermometers for the feed water; flue temperature and steam temperature; recording gages for the furnace and damper drafts and thermoelectric pyrometer for temperature investigation.

It is intended in this course of instruction to indicate to the engineers and firemen the value of different parts of the boiler, the most efficient methods of firing, the use of the various instruments necessary in detecting efficiency losses and the value of smokeless combustion, the effect on efficiency of soot and scale accumulations, the effect of various sizes and kinds of coal and the most efficient percentage of CO_2 in the flue gases.

Not only will this be demonstrated on the test boiler, but when a condition of efficiency is obtained, it will be immediately carried out in the operation of the rest of the plant and a practical demonstration made of the possibility of applying these conditions to an entire plant.

Mr. Chubbuck, vice-president executive of the Illinois Traction System, has shown great progressiveness in thus establishing this first school of its kind in street railway power plants.

Mr. Harrington was for many years the chief engineer of the Green Engineering Co. of Chicago and Mr. Peebles was his assistant in the engineering department of the same company. These gentlemen have had to do with the design, installation and operation of nearly a thousand stoker installations, comprising substantially every state in the union and all of the coals mined in this country. They are advising engineers on problems of boiler-room design, construction, operation and organization. Offices at 220 So. State St., Chicago.

THE UNITED STATES CIVIL SERVICE COMMISSION will conduct an examination for heating and ventilating engineer and draftsman on April 22 and 23, 1914, at principal cities to fill vacancies in the Office of Supervising Architect, Treasury Department, Washington, D. C. The salary is $1200 a year. Further information may be had by sending for application Form 1312.

Foreign Development in the Power Plant Field

A New Tempering Process, Plating Aluminum, Sugar in Concrete. By J. H. Blakey

VICKERS & CO., England, has put into its workshops a new process for the tempering of cast or forged steel of any dimensions, which produces no deformation in finished pieces, and which does not affect the condition of the mass of the metal created by previous heat treatment. The tempering can be localized at any point of the surface, and the pieces treated are immediately ready for use without any further operation. The process consists of a very rapid surface heating, followed by immediate quenching. In the case of a toothed wheel, for instance, the wheel is made to revolve in a tank of water; the speed of revolution and the intensity of the heat are so regulated that each tooth remains under the flame just long enough to reach the correct temperature.

Usually, the tempering reaches a depth of about 0.06 in.; by means of decreasing the speed of rotation of the wheel and thus increasing the amount of heating, it may be made to reach a depth of 0.1 in., or more, if required. The flame is given an undulating or rotary movement to prevent burning. The degree of hardness can be varied according to requirements, by modifying

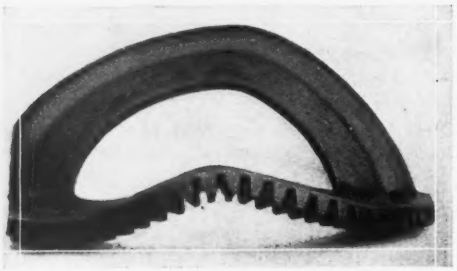


FIG. 1. CROWN WHEEL SURFACE TEMPERED BY VICKERS' PROCESS AND BENT IN TESTING

the temperature of the water, or by manipulation of the flame. In the case of automobile gears, for instance, the surface of the teeth can be made as hard as glass, while the flanks are left comparatively soft. This method of tempering produces no cracking on the surface of finished pieces, and the metal shows no tendency to rupture at the line where the soft interior joins the tempered area.—From La Nature.

Nickel Plating of Aluminum

At the meeting of the French Academy of Sciences in Paris on the 12th of January, MM. Canne and Tussilly presented a note describing a method for the nickel plating of aluminum, which, until now, has not been possible. The preliminary cleaning of the metal is done by boiling in a bath of potash and then brushing with whitewash, after which, it is washed in a plentiful supply of water. It is then placed, for a few minutes, in a 2 per cent cyanide of potassium solution and again washed with water. Finally it is treated with a hydrochloric acid bath containing iron. This bath consists of parts, by weight: Hydrochloric acid, 500; water, 500; iron, I. After immersion for some seconds, the metal takes the appearance of watered silk. It is then removed and again washed in a copious supply of water. The metal is now ready to be placed in the electrolytic bath. Experiments have been made with both chloride and sulphate baths, and it has been found that the chloride bath invariably gave the better results.

After plating, the metal appears dull white, taking on a brilliant polish when rubbed with a wire brush. The adherence of the deposit of nickel on the aluminum is remarkable. The pieces can be hammered or bent, without separating the nickel, and it cannot be melted off at a temperature lower than the fusing point of the aluminum.

Effect of Sugar in Concrete

A writer in Prometheus recalls the fact that recently a concrete structure in England was found to have localized defects due to a small amount of sugar having gotten into the concrete, which had the effect of preventing setting. The cement had been shipped in a vessel which had previously carried a cargo of sugar. Some of the bags having burst, the cement had been gathered up with a shovel, and in this way a small

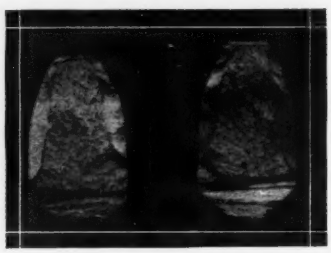


FIG. 2. BROKEN GEAR TEETH SHOWING DEPTH OF TEMPER

amount of sugar had been mixed with it. In another case, the cement had been put into sugar sacks which had been previously shaken; in this case, also, the small amount of sugar remaining had been sufficient to prevent setting. On this occasion, tests were made which showed that a proportion of 0.25 per cent of sugar was sufficient to render the concrete useless. On the other hand, the Chemisches Laboratorium fur Tonindustrie at Berlin has found that an addition of from 1 to 2 per cent of sugar favors the setting of the concrete, but with the disadvantage of rendering it friable. Similarly, it has been proven that solutions of sugar may be injurious to concrete already set. Consequently, there is reason to believe that in sugar warehouses and factories a special inspection should be made from time to time of pillars, beams and floors of concrete.

The new addition to the plant of the Blackstone Mfg. Co., Woonsocket, R. I., is nearly finished and a new Stirling water-tube, 250-hp. boiler will be installed, along with the 4 boilers of the same kind now in use.

LETTERS DIRECT FROM THE PLANT

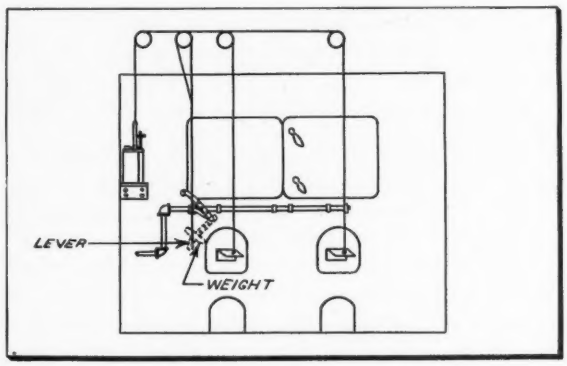
Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Improving Operation of Smoke Consumer

THE SMOKE consumer I am operating on my boiler is composed of an oil cylinder and solid piston working within. The piston is raised, when firing, by the hand lever which is connected to the piston by a chain, and also a series of chains over pulleys to small air doors on the front of the boiler, as shown on the sketch.

In my experience with smoke consumers, friction seems to increase either in the cylinder or automatic closing steam valve when the consumer is on the point of closing up. When it fails to close properly, too much steam passes through the steam jets, which represents a dead loss. The oftener you have to fire, the greater the loss.

The weight on the lever must balance the weight of the small air doors, so when the lever is pulled down it will remain down until the moving piston commences



SMOKE CONSUMER CONNECTIONS TO BOILER

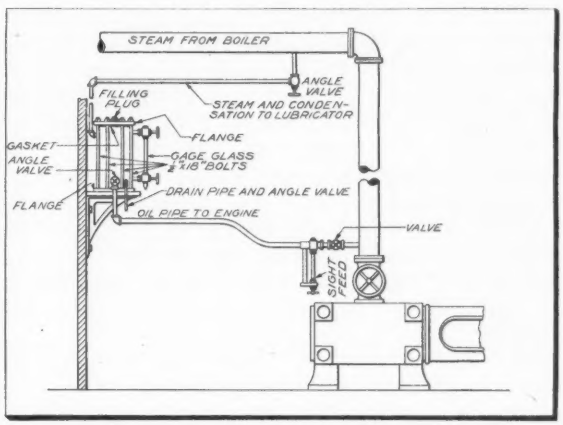
to raise the lever connected to the steam valve. In order for the consumer to close efficiently it was necessary to overcome this excess of friction, or weight of lever.

I designed a shifting weight on the lever and it works satisfactorily. When the lever is pulled down, the weight slides to the end of the lever, as shown by dotted lines on the sketch, when the valve is closing and lever reaches an angle of about 45 deg. the weight slides down to the valve stem end and relieves the lever of the shifting weight, allowing the consumer to close. The sketch shows the lever in its lowest and highest positions. The automatic steam valve is open when the lever is in its lowest position, as shown by dotted lines, and closed when the lever has reached its highest position. The automatic steam valve connected to the lever is a butterfly valve. THEO. GROSS.

Lubricator of Large Storage Capacity

WHEN STEAM plants, especially isolated plants, are installed, the owners frequently aim to reduce the first cost by skimping on the fittings and fixtures as much as possible; for this reason, lubricators of a size to lubricate the boiler feed pump are put on engines of 200 hp. and larger, and require filling many times in a day. The engineer is not always present when the lubricator becomes empty; the glass gets clogged with oil, making it impossible to see whether it is feeding or not, to say nothing of the time the engine had been running without oil.

Having met so many such cases, I concluded to better conditions in one plant and, finding suitable material at hand, constructed the lubricator shown in the illustration, with a piece of 10-in. pipe 16 in. long. I faced up



LUBRICATOR AND PIPING

each end, made 7 ½-in. bolts 18½ in. long, took 2 blank flanges, drilled holes in them for the bolts and a hole in the center of one for a filling plug. I put a 1/32-in. gasket under each flange and clamped them tightly over the ends of the pipe. Five holes were drilled in the piece of pipe, 2 for a gage glass, one for the steam and condenser inlet at the back near the top, one at the bottom for the oil line to the engine, having an angle valve outside, a nipple being screwed through the pipe, had one elbow attached pointing up with a short piece of pipe connected passed upward inside, to about ½ in. from the top flange, the end being open to receive the oil as it rose on top of the water in the lubricator, passing down through the angle valve to the oil line, to the engine, through the sight-feed glass, where the amount fed to the cylinder was regulated by a needle-point valve at the bottom of the glass, as with the ordinary lubricator.

A valve was placed between the sight-feed glass and the steam pipe. An angle valve and short piece of pipe were also connected by a close nipple to the bottom for drawing off the water when refilling. When completed, the lubricator was placed on a shelf on the wall. A 1-in. pipe 4 ft. long, reduced to ½ in. at each end, was used as a condenser and a ½-in. line run to the steam line overhead, having a ½-in. stop valve to shut off the lubricator.

This lubricator held 18 qt. of cylinder oil and required refilling every 20 days. The lubricator has never run out of oil in 2 yr. service, for when the oil has been used up to the stuffing box nut on the top of the gage glass, there is still 2½ days' supply left in the lubricator. The feed is regulated to 3 drops a minute for a 24 by 44-in. cylinder. This insures constant lubrication to the engine and, as the lubricator does not get entirely empty, it saves the excessive and annoying troubles of swabbing out the sight-feed glass.

In the majority of cases where sight-feed glasses become clogged up, it is on account of the fluid in the glass, as well as the oil becoming warm enough to stick to the inside of the glass and pipe connections; this is more common with some kinds of cylinder oils than others. Some engineers stop the plugging up of the glass, by removing the feeder point and soldering a small piece of wire to it as a guide for the oil to follow up through the glass. This prevents the drop from taking the usual zigzag course, which generally results in the drop sticking to the side of the glass; but in many cases, it is much harder to regulate the amount of oil fed to the cylinder, as the drops will be small when the lubricator is warm, while, if it is fairly cold, the drops will be much larger.

There are many liquids prepared to put into the sight-feed glasses to prevent the oil sticking to them. Some engineers use glycerin, but this does not meet with success in all cases. One must find, by experiment, the kind of fluid best suited to the weather conditions in his plant, and not select one that will unite with oil and pass over into the engine cylinder.

R. A. CULTRA.

Boiler Plant Data

WHEN I recently moved East, the mill to which I went had one of the best equipped boiler plants that I have ever seen. The boilers were 500-hp. Stirling, 15 in number, and all equipped with Taylor underfeed stokers. Greene fuel economizers were used. Coal was delivered to an overhead bunker by means of a bucket conveyor, whence it was fed to the hoppers of the stoker by gravity. From the hopper the coal was forced on the grate by plungers which, in this case, were of such dimensions that each stroke accounted for 15 lb. of coal. By means of an automatic device, the number of plunger strokes for any period of time was recorded, which gave a simple method of measuring the coal used. The draft was mechanical, air being forced through openings in tuyere blocks.

I was favorably impressed by a few of the more noticeable features and those which struck me most forcibly are as follows:

(1.) The automatic control of coal and air—this means economy when handling a variable load.

(2.) The gas and air mix and rise together through an incandescent bed of coal, hence combustion is complete within a short distance from the fuel bed.

(3.) Positive draft is used, therefore weather conditions have but little effect on the furnace draft.

Tests had been made from time to time and some of the data may be of interest to readers.

Analysis of coal:

Volatile matter	23.12%
Sulphur	0.70%
Fixed carbon	68.94%
Ash	5.23%
Moisture	2.01%

Average coal used per horsepower per hour ..... 3.00 lb.

Analysis of flue gas:

CO_2	12.9%
O	6.2%
CO	0.1%

Temperature of air entering boilers ..... 86 deg. F.
Temperature of gases before economizers .... 534 deg. F.
Temperature of gases after economizers ..... 282 deg. F.

Analysis of refuse from boilers:

Combustible	30.5%
Ash	69.5%

Heat of combustion per pound of coal ..... 14,500 B.t.u.

	With Econ. B.t.u.	Without Econ. B.t.u.
Loss due to moisture in coal	25	27
Loss due to moisture formed by burning H	385	425
Loss due to heat carried away in dry chimney gas	872	2000
Loss due to incomplete comb. of C. to CO	67	67
Loss due to combustible in ashes	344	344
Total heat losses in B.t.u.	1683	2853
Per cent heat lost per pound of coal	11.6	19.7

H. H. LATIMER.

How Rope Drives Wear Out

I READ with interest the criticism of the Dodge Manufacturing Co., and I am sure they are better acquainted with rope transmission problems than I am; but I would like to make a little amendment to the statement—"In the majority of cases, where the rope drive is properly designed, there will be no internal wear."

Design is important, but it is not everything. A steam engine, for example, that might be perfect in design, can wear out in a short time, if it is not properly cared for. Anything, in fact, that must withstand wear can be made to wear longer through proper care, and it was for this reason that I wrote the first article. Even though a rope drive is properly designed, it will wear internally if it is not correctly cared for by means of a lubricant that will prevent the fibers from wearing out by grinding against one another.

I am in perfect accord with the remainder of the Dodge Co.'s article and am sure they will agree with my statements above, which are, I admit, based on a technicality.

W. F. SCHAPHORST.

Filling a Boiler

THE WRITER was in a small plant, some time ago, and the method used in filling the boiler there was, to say the least, hard on one's patience. Water was fed into a tank from the city, the tank being about 15 ft. from ground and about 8 ft. high, fed from an inch pipe which, owing to its great length and elevation, had little force; it will be seen that by the time the boiler was washed, the supply was necessarily somewhat diminished.

The heads were then put in and the water column lift opened to allow escape of air, and the water from the tank was allowed to flow into the boiler. The way it got in follows: From the tank into a 2-in. pipe to a tee and then down to ground level through a 1-in. pipe, this pipe running the length of the boiler and connecting to the injector, the water rose through the injector and its steam pipe and ran into top of shell; also, a small amount would return to the rear of the boiler and enter the blowoff pipe through the injector discharge pipe. It required 2½ to 3 hr. to fill the boiler to 1 gage.

Next washout day, I was there and connected a 1-in. line from the tee previously referred to, leading it into rear man head. In about 20 min. water was up to manhole, when head was put in and connection to injector remade and boiler was let fill up to 1½ gage, which required far more time than filling up to the head had. Many an hours' work can be saved by looking out for these little things.

J. C. LEE.

Position of Valves on Steam Lines

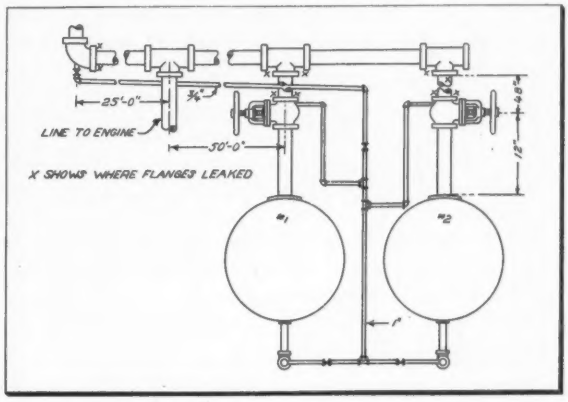
VALVES SHOULD be placed as near the boiler as possible, and where the branch from the boiler has to run any distance to the steam header, it should be protected by 2 valves, one of which should by all means be a nonreturn. In fact, I believe that all state laws should require a nonreturn valve wherever 2 or more boilers are on one line.

In the plant where I am now, we have 8 boilers connected to one header by branch lines about 15 ft. long. The valve next the boiler is a nonreturn angle valve and is set directly on the steam outlet flange. The other end of the branch is protected by a gate valve. When cutting these boilers in, it is always the rule to open the gate valve shortly after lighting the fire, care being taken to drain the line by opening the chain, provided for that purpose, until dry steam blows. The stem on the nonreturn is then opened up and the boiler allowed to cut itself in.

I believe this is better practice than to cut it in by the gate valve. We have 6 of these boilers down every Sunday to wash out and when putting them on the line, if each boiler had to be cut in by hand it would keep 2 or more men pretty busy for a while, one to watch the gages and another to open the valves.

While speaking of these boilers, I wish to take exception to an old standard rule, that a boiler should be filled to the middle gage cock. In filling these boilers, one gage is all that is ever put in and by the time steam is raised to working pressure (150 lb.) there are 2½ gages of water present. These are Stirling 250-hp. boilers. Mr. Hawkins is right when he says that the engineer does not always cut in the boiler. Here in Ohio we have boiler plants that are in charge of water tenders, a great many of whom are careless, or at least do not know how to cut in boilers, and these are the class of men that must be protected against themselves.

The first plant I ever had charge of was in Indiana. That's about 12 yr. ago. I had a plant consisting of 2 boilers. The steam main was connected as shown in the sketch. About 75 ft. from the boilers it was piped to the upper floors, where steam was used in steam cookers, and also to a 10-hp. engine. This main was pitched away



METHOD OF RETURNING THE CONDENSATION

from the boilers and at night always filled with water which had to be drained out through the engine. Pretty poor practice, that. I asked for a trap to put under that ell and one to put on the boilers, as Mr. Linton shows on page 166, but was told, "We have spent enough money on this plant for it to be first class and do not intend to spend any more."

Then I figured out a way to overcome that trouble. I got some old piping and connected it as shown in the sketch. That cured the trouble immediately. The firm consented to covering that pipe after it was connected.

I believe I got better economy this way than I would with a trap and throwing that water away.

H. SKATON.

Repairing a Steam Pump

SOME TIME ago, I was asked by the company I am with, to try to do something for a single-cylinder, Blake and Knowles, piston steam pump. The company that made it, had sent a man to repair it, but it would not run without constant attention. The steam end of this pump has no outside valve rods, but the slide valve is reversed by 2 reversing valves, one in each end of the cylinder.

This pump would make the inner stroke all right, but would not return unless the starting hand lever was pressed over. At first I thought the steam piston was loose, as quite a quantity of steam would blow through when the end of the inner stroke was completed. I removed the head and found the nut loose on the piston rod. After tightening it and putting on the pump it ran fine by just regulating the opening in the cock to correspond with speed of pump. The same results probably could have been accomplished by plugging the pinhole in the plunger at this end, but that would allow the pump to run at only one speed.

F. H. BLIVEN.

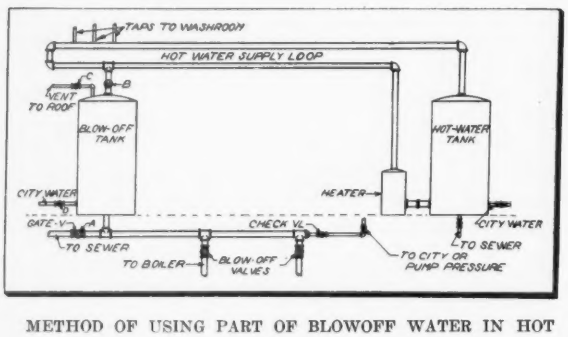
Success With Reheaters

In a recent issue an engineer asks advice about a reheater. Most of my experience as master mechanic of a large mining company with air has always showed success where a reheater is used. It does not only do away with frost troubles but it will increase the air expansion, so that about 20 per cent saving is found. I have used several Sullivan reheaters and have found them to eliminate trouble and time lost in thawing drills and pumps. W. H. Powell.

Supplementing Hot Water System

Illustration shows how an insufficient hot water supply was overcome at nominal expense to replenish the supply during the period of maximum demand. This system may be used alone or in connection with regular heater whether heated by steam-coil or separate coal or gas heater.

Set blowoff tank on the floor line or below if desired. The tank in this instance is of 300 gal. capacity. Regular heater arrangement may be at some distant point as shown, loop for supply and circulation running to the source of demand.



METHOD OF USING PART OF BLOWOFF WATER IN HOT WATER SYSTEM

Blowoff tank connects to one or more boilers as shown. Top of blowoff tank is connected to loop with same size pipe as loop, with globe-valve "B" between.

Tap in at side near bottom with cold water city pressure or from pump, same pressure per square inch as in the other tank.

Blow down boilers until tank is full, first opening vent C to roof, and closing valves D, B and A.

Let the water settle at least one hour, after which let out about ⅓ to sewer by gate valve, A, to get rid of sediment. Close A, open water valve, D, until tank is full, hot water, of course, remaining on top. Close vent C and open B until the hot water is used up. I have experienced no difficulty with the quality of water for toilet purposes when directions are followed in regard to settling. I use boiler compound daily and the water shows no discoloration. A. D. Mead.

Operating Troubles

In the first case, an electric light station had Curtis vertical turbines exhausting into surface condensers and with vertical engines driving dry vacuum pumps. After taking my day watch, I found that the vacuum was hard to maintain. The circulating pumps were motor driven and up to speed and apparently getting plenty of water; my attention was called to the engine running the dry vacuum pump which would first race, then slow down almost to a stop and then run again, which bothered the vacuum tremendously, so I discovered that the stuffing box gland on the Waters governors valve stem had been previously screwed down solid, gripping the valve stem so that the governor balls had difficulty in moving them, causing the unsteady speed. After loosening up there was no further trouble.

In the same plant, we had an accumulator which was used as a reserve for pressure on the step bearing of the turbine, so in case the step pumps should stop, the step pressure would be maintained for about 10 min. while the accumulator was descending, giving time to stop the turbines and thus save the step bearing plate from injury. Now this, as well as all other accumulators, had a top and bottom limit attachment, which, when in place, would give warning that the accumulator was nearly down as well as the step pressure; but in this case the bottom attachment had been misplaced previous to my watch and the steam pressure got so low due to heavy load, that the step pumps decreased in speed and only too late it was discovered that the step pressure was so low that the step bearings were grinding together, which required removal.

In still another plant containing 6 hydraulic elevators, I had 3 tandem compound duplex steam pumps with 16-in. high-pressure and 20-in. low-pressure steam cylinders pumping against 140 lb. in the pressure tank, each cylinder having compression valves. Now one day I experienced trouble in maintaining the pressure in the pressure tank at 140 lb., nor could the pump be speeded up fast enough to get it. I afterwards discovered that the man on the previous watch had closed tight the compression valves on each cylinder, which, of course, shortened the stroke about an inch, hence the low tank pressure.

In still another plant, when first starting up, I found that a 12-in. vertical rubber belt had slipped off and upon examination I found that the belt had been smeared with Albany grease, and the bearing at the bottom had a ⅜-in. pipe, 6 in. long, which carried the oil to the bearing and I found it filled so hard with sand that I had to drill it out.

In another plant which had been started up for the first time, the erecting engineer wanted to get the oil trade, but had been informed that another had secured the contract, so the engine was started and it was found that the main journal heated, which was at once laid to the oil by the erecting engineer, but further investigation by the owner showed that ground glass had been put in the bearing and no doubt by the erecting engineer, who wanted to sell his oil.

In a certain plant, a new engineer took the job and he found it hard to keep up steam for a few days, and not being acquainted with the plant, he thought it was the heavy load, when finally looking over the damper regulator he discovered that the stroke had been so shortened that the damper did not half open and after getting its full stroke, it was easy to keep up steam.

In a plant containing a 22 by 48-in. Putnam engine, the regular engineer wanted to take a day off, so he put in a reliable engineer to run for him that day. Now,

when the new man tried to start the Putnam, he could not make it budge, and after 15 min. delay, he found that the exhaust valve was stuck open which, of course, prevented him from getting a head of steam, as it was blowing through the engine. Now it was the tight stuffing box gland on the exhaust valve stem which had been screwed up solid by some other person, who wanted the boss to think that "he and he only could run that engine."

I have much trouble in getting firemen and assistants to realize the importance of blowing down boilers every day, and have to resort to some method in order to know if the blowoff had been open, so here is one way, if kept secret, that will help. Take a black hair from an ordinary brush broom and lay it on the slot on top of the blowoff cock, and as it will project out over, you will see that the fireman cannot put a wrench over it without knocking off the hair, and yet he cannot see it. I have many times asked the firemen if they blew down the boilers and they will always say yes, and I would secretly go behind and find the hairs just as I placed them. I have known firemen to go over a week without blowing down. It is no use to tell them how you know, but discharge them after giving them a good show.

In a certain plant of which I became engineer, I knew the engine to be steady in its speed and never to give any cause for trouble before I took it. The engineer got a better job and said I could have his, so I started in and the first day the engine gave me much trouble on account of fluctuating speed, yet the indicator cards showed no apparent defect; I found the trouble was that the oil in the governor gag pot was so thick that it must have been cylinder oil unadulterated, yet the day before I could not see that the other man had any trouble at all. After replacing this cylinder for kerosene oil there was not the slightest trouble.

A. C. WALDRON.

Preserving Brine Temperature

IN A certain plant in which there was being installed the necessary machinery for ice making and refrigerating purposes, things were arranged so that the ice making end of the equipment was completed first, and placed in operation. This was necessary owing to the demand for ice at that time. The general layout of this part of the plant is shown in the sketch, the centrifugal pump being used to circulate the brine through the brine coolers where it is cooled to the desired degree, and discharged into the freezing tank. The suction pipe of the pump is connected to the opposite end of the freezing tank, as shown. The tank contains a set of expansion coils proportioned for that size of ice tank.

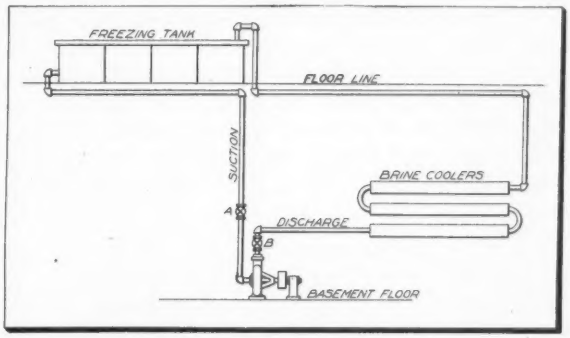
The brine cooler was installed to cool brine for other purposes when the plant had been completed, but the arrangement is such that the brine will always pass through the freezing tank and assist in freezing the ice. The freezing tank takes the place of a surge tank for the brine pump, and as the tank has no agitator the brine pump keeps up the circulation through it.

A controversy arose between the erecting engineer and the operating engineer in regard to shutting the valves A and B at night, the plant being operated only during the daytime.

The operating engineer's contention was that with the valves open the natural circulation of the brine would warm it up considerably and also that considerable leakage might occur at the stuffing box of the pump.

The operating engineer noticed every morning that the thermometer in the back end of the freezing tank registered 24 deg. and that the piping between the pump and freezing tank would be covered with frost.

In course of time, this part of the equipment was turned over to the operating engineer, which gave him an opportunity to prove his argument. Shutting the valves referred to, at night, in the morning he found the temperature at 14 deg. and all of the connecting pipes free of frost. These temperatures, of course, were not always found at the same point, but the difference was usually about 10 deg. Ten degrees in the amount of brine affected by this difference in temperature, in a 10-ton ice tank, meant considerable difference in getting things cooled down for the day's run.



ARRANGEMENT OF BRINE PIPING

The brine piping had not, at that time, been insulated and every heat unit absorbed by the brine meant so much more work for the ammonia compressor to do. This is what the operating engineer had in mind when he suggested that the valves A and B be closed at night. When the erecting engineer's attention was called to this difference he had little to say. Apparently it is a good idea to look after the small matters. W. S.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for sanitary engineer for field duty, at salaries ranging from $2000 to $2500 a year. The duties of this position will be to engage in research work in connection with field investigations of stream polution, water purification and the treatment and disposal of sewage and industrial wastes. Applicants should be competent to take responsible charge of investigations of a research character involving the chemistry, biology and engineering features of this class of work. Competitors will not be assembled for examination, but will be rated on the following subjects, which will have the relative weights indicated: General education and technical training, 40; technical or professional experience and fitness, 40; publications or thesis, 20. Applicants must have reached their 25th but not their 35th birthday on the date of the examination. Persons who meet the requirements should at once apply for application Form 304, and special form, to the United States Civil Service Commission, Washington, D. C., using the title Sanitary Engineer (Male).

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Piston Ring Queries

WHAT DO you have to do to a new set of snap rings before putting them on the piston of an engine?

2. What diameter of snap rings would you order for a 12-in. piston?

3. Supposing the rings were just cut across, how would you know, without figuring, just exactly how much to take out in 1 cut to bring a ring to the required size?

4. Suppose you fitted a new snap ring to a piston of an engine and the ring proved to be too narrow for the recess, and every time the engine took steam on that end, the incoming steam caused the loose ring to knock. What would you do to stop it without getting a new ring?

5. If you ordered rings for piston and they came too large, how would you fit them so that you would not have to make more than 1 cut?

6. A new duplex pump runs short stroke on 1 side and the same amount of lost motion is given to each valve when the valves are set. What makes it short stroke, and what can be done to stop it? A. A. W.

A. Fitting a new set of rings will depend to some extent upon the construction of the ring. Taking the ordinary spring or snap ring, it should be tried in the groove to see that it is a good fit, not too tight nor too loose. Then try it in the cylinder to see if the cut is wide enough, a little allowance being made for unequal diameter of the cylinder and for expansion of the ring in heating up. If found to be a good fit, or after being fitted the edges of the ring should be well rounded off, as a sharp edge will tend to scrape the oil off the cylinder walls, and will likely cause cutting or an excessive amount of oil will be required to prevent the piston from groaning. Also see that the dowel pin or thick side of the ring, if it is of the eccentric type, does not cause the ring to stick out of the groove too far.

2. I should order the ring finished to a diameter of 12 1/32 in. The proper way to turn the outside diameter of the ring is to make it a little larger than the actual diameter of the cylinder, say ¼ in., and after cutting out about ¼ or ⅜ in. on a 12-in. ring, it is squeezed together and put in the lathe again and returned to the proper diameter, allowing about 1/32 in. larger diameter for wear, or 12 1/32 in. When this is done, the ring will have tension enough to keep it from leaking, and at the same time will have the same curvature as the cylinder walls, which it would not have if made to a larger diameter and then sprung into the cylinder. In giving dimensions for the diameter of the ring, the engineer should state the diameter of the cylinder instead of the diameter of the ring, and that it should be re-turned to the desired size after being cut, which will make it a true circle. The diameter of the cylinder should be used instead of the diameter of the piston, as the latter is smaller than the cylinder, and, if made to this size, the ring would not be a good fit. The other dimensions would be determined from the piston.

3. The best way would be to spring the ring into the cylinder, allowing the ends to lap over and measure the amount they lap, making allowance for expansion. This would be more accurate than figures, unless the exact diameter of the cylinder were used, and even then the chance of error would be greater.

4. If the ring were too narrow, I would cut out a shim to fit into the recess in the piston, but with a little smaller outside diameter than that of the piston, and of the proper thickness to fill up the space between the ring and the piston. The thickness could be determined by trial, or by a thickness gage. The shim could be made in 2 or 3 pieces if desired, and should be of some hard material, such a sheet steel, or better, phosphor bronze, to prevent its wearing away.

5. The surest way would be to proceed as stated in answer 3. That is, by trying the ring in the cylinder and cutting out the required amount. I should first squeeze it together and measure it to see if it was turned to a greater diameter than it should have been. If a true circle and yet too large, it should be turned down to the proper size to make a good fit. If, when closed up to the right diameter it was a true circle, the ends could be cut off as required. It may be thought that all this extra work is unnecessary in fitting the ring, as it will wear to a fit in time, but the loss of steam during the time it is wearing to a fit will pay for properly fitting many times over.

6. There are several things that will cause a pump to short stroke on 1 side. If the plunger on 1 side is packed too tight, it will cause that side to make a shorter stroke than the other side. The compression cocks on the steam cylinder may be open on the long stroke side and closed on the short stroke side, which causes the compression to get high enough to balance the initial pressure before the end of the stroke is reached. If the valves on 1 side are broken or caught up, or the piston is air bound, the piston on that side will make a long quick stroke, and the 1 on the other side will make a short slow stroke. It might be caused by other things, but is not likely. It may be caused by lost motion in the valves, but not unless the valves are improperly set or are not of the proper dimensions. The remedy to be applied would depend upon what the trouble was. Examine the compression cocks, packing, valves, etc., as the action of the pump would indicate. J. C. HAWKINS.

Setting the Valves on a Vertical Engine

ON A piston valve engine (no peek holes to see valve), the steam makes the most noise while the engine is on up stroke, while on down stroke you can scarcely hear any rush of steam. Which way must the valve be moved? This is a fore and aft compound and I am referring to high pressure cylinder. W. J. N.

A. The question does not state whether the valve admits steam to the cylinder past the ends or through the middle of the valve, nor whether the noise of the rushing steam comes from the inlet or the exhaust. Correct valve setting can be accomplished only with the aid of the indicator, but good results may be obtained without it by careful and accurate measurements.

In the case of the piston valve all the work must be done from measurements taken from the outside of the valve chest. In the case given, for a quick job of valve setting without taking off the valve cover, block the crank slightly off the center, open the throttle until steam blows through into the cylinder and out of the drain cock. Loosen the eccentric and turn it backward until the valve just covers the port and the steam stops blowing. Make a mark on the valve stem at some certain distance from the face of the stuffing box. Now, turn the eccentric until the valve moves enough to allow steam to blow from the pet cock at the other end of the cylinder. Move the valve back until it just closes the port and make another mark on the valve stem at the same distance from the face of the stuffing box as the other. These 2 marks on the valve stem give the open positions of the valve for both strokes. Put the engine on the center and turn the eccentrics in the direction the engine is to run, until by measurements from the marks to the face of the stuffing box it is found that the valve has the proper lead, and fasten the eccentric. Then put the engine on the other center and see if the lead is the same at both ends. If it is not, the length of the valve stem should be changed one-half of the difference in lead and the eccentric reset.

F. L. J.

Pump and Boiler Questions

1. WHY DO you give lost motion between the valve and valve-rod when setting the valves on a duplex pump?

2. Would you block up tight under the mud drum of a B. & W. boiler?

3. How about the Stirling boiler?

4. Why are the tubes of the B. & W. boiler on an incline?

5. Why not in the Heine?

A. K.

A. The piston of a duplex pump takes steam full stroke, and the valve is made without lap or just long enough to cover the ports when central. As 1 piston rod works the valve on the other side, some lost motion must be given to allow 1 piston to make a full stroke or nearly so, before the other starts. This is best done by making the distance between the tappets on the valve stem greater than the thickness of the valve lugs. If there was no lost motion between the valve stem and valve, the second side of the pump would start as soon as the first side, and as both valves would be moved, the pump could make only a short stroke. Further, both plungers would discharge at the same time, making the flow of water intermittent. If lap was added to the valve, the pump might stop in such a position that it could not be started.

2. B. & W. boilers are suspended from I-beams above the steam drum, and the mud drum is carried by the rear headers and nipples. As all of the several parts expand when heated, ample clearance must be left under the mud drum for this purpose, to prevent buckling of the tubes. There should be not less than 1 in. space all around between the mud drum and brickwork. This space may be filled with asbestos rope, which will allow for the expansion, and at the same time prevent air leaking in at this point.

3. The Stirling boiler is suspended in the same manner as the B. & W. boiler, and the weight of the mud drum is carried by the tubes. There is no blocking under it, and it is free to expand in all directions. The bridge wall, however, is built tight against the front side of it.

4. The steam drum of the B. & W. boiler is level, and the tubes are placed at an angle of about 30 deg. to the horizontal drum to give more rapid circulation of the water through the tubes in the proper direction, and also to give more space between the grates and tubes for proper combustion.

5. The tubes in the Heine boiler are set on an angle of about 15 deg. to the horizontal, as in the B. & W. type, but the distance from the tubes to the drum is the same at both ends, and the whole boiler is set on an incline, the front end being the higher. The water line in the steam drum, instead of being at a given height the entire length, is a diagonal line from the lower part of the front head to the upper part of the rear head. In all the water-tube boilers of practical design, 1 end of the tubes must be higher than the other end to give proper circulation. If this was not done, the circulation in the level tubes of small diameter would be slow, and, consequently, as the efficiency of the boiler depends to a great extent on the rapidity of the circulation, those with level tubes would be very inefficient. In the 2 types just mentioned, the same end is attained in different ways, but both types have the tubes set at an angle to the floor line.

THE NEW ENGLAND SOCIETY of Superintending Engineers held its regular monthly meeting and dinner at the American House, Boston, on the evening of Feb. 26, at which the newly elected officers were installed: President, L. H. Brown, chief engineer Bay State Street Ry. Co., Lynn, Mass.; Vice-President, Thomas Armstrong, chief engineer Boston Safe Deposit & Trust Co., Boston; Secretary, Stephen Barnaby, chief engineer Copley-Plaza Hotel, Boston. The installation was conducted by Past President George W. Walsh.

The speaker of the evening was Mr. C. Leach, manager Taylor Stoker Co., who gave an illustrated lecture on automatic stokers and the smokeless combustion of fuel.

Mr. F. L. Fairbanks, chief engineer of the Quincy Market Cold Storage Co., also gave an illustrated lecture on the efficiency of multi-stage centrifugal pumps.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Distance from Boiler to Grates

WILL SOME reader kindly tell me the best distance from boiler to grates for burning green slab wood? I have a rated 45-hp. boiler, 48 by 12, with 36 3½-in. tubes, 23 in. from boiler to grates originally; but I lowered the grate 6 in. The grates are 48 by 48. Would it be advisable to lower them more? The boiler is in a laundry; the load is variable. We are using green fir slabs from the mill. E. B. A.

Taking the Examination

IN ANSWER to J. E. K. in Feb. 15 number: The first question, on what he knew about a slide valve, was answered in a foolish way. He probably realizes now that he does not know all about it.

2. How would you set the slide valve to run in the opposite direction? With a direct movement where the eccentric is set 90 deg. plus lap and lead ahead of the crank, to make engine run the opposite way loosen the eccentric from the shaft, then turn the eccentric back to the other side, so that it will be 90 deg. plus lap and lead ahead of the crank set eccentric to shaft, then move the engine to the other center and see if lead is the same at both ends.

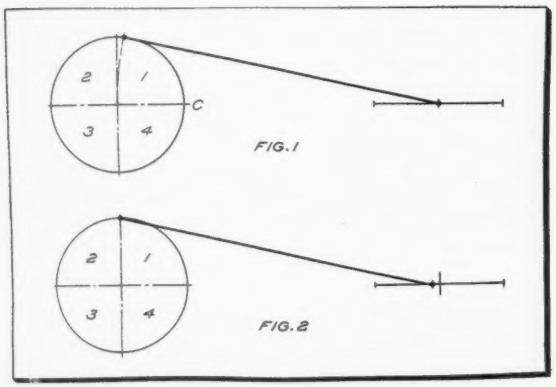


FIG. 1. POSITION OF CRANK PIN AT MID POSITION OF PISTON

FIG. 2. POSITION OF PISTON WHEN CRANK IS IN QUARTER POSITION

3. Why does the engine run backward if your valve has same lead and at same place as it was before? With direct movement the crank follows the eccentric; therefore, if you set eccentric to run under or in the opposite direction, the crank will follow.

4. With the Fitchburg governor, if the weight broke, the governor would be unbalanced and would pound so you would have to shut down.

5. With the link breaking, the engine would work the same as with a broken weight.

6. Where would you put the try-cocks? The try-cocks must be within the visible sight of the gage glass; therefore, with a glass set 1 in. above the fusible plug or 3 in. above the tubes in a return-tubular type, I would have the first cock 1 in. above the bottom of the glass, the top one 1 in. from the top of the glass, and the middle cock even with the center of the glass.

7. Dividing the crank circle into 4 equal parts, over which 2 parts of the stroke would the piston travel the fastest? The piston travels the fastest over the first and fourth quarters of the circle. By Fig. 1, you will see that, owing to the angularity of the connecting rod the crank pin has not reached the end of the first quarter, but the piston has reached half stroke. In Fig. 2, the crank has reached the end of the first quarter and the piston has traveled beyond half stroke. As the piston moves farther during the first and fourth quarter than in the second and third, it stands to reason that it must move faster. W. N. L.

Trouble With Boiler Flues

IN ONE of our 125-hp., return-tubular boilers, 18 ft. by 72 in., we had an unusual occurrence on March 5, in regard to which I wish your advice. We inspect and clean out our boilers once in 3 weeks, and our previous inspection did not reveal any indication of such a thing happening.

At the back end of the respective boiler, ⅔ of the flues started leaking. I had them expanded and tightened in the usual way, and, thinking everything was all right, was surprised to find them all leaking before we got our fires started. On opening up the manheads, we found the staybolts badly warped and twisted, and stretched to about 2½ in. longer than usual. We are troubled with scale about 1/32 in. thick in our boilers, and about 1/16 in. thick on the flues. We have forced draft, Palmer system. J. E.

Crooked Answers

JUST AS an indication of lack of attentive reading and clear thinking, the following answers given by a candidate in a recent civil service examination for mechanical draftsmen are interesting. To test your knowledge, how many of them can you correct?

"Watt is condensed voltage.

"Ft. lb. is weight per linear foot.

"Momentum is turning.

"Ohm is part of a material.

"Volt is the given power.

"Tensile strength is the least or fiber strength.

"Specific Heat is the most that can be obtained.

"Gage Pressure is the highest pressure that can be given.

"Absolute pressure is the least pressure that can be produced.

"Heat Unit is heat at every step of operation."

Heating Surface Required

A. L. WISHES to have some information on the radiation required to heat the fourth story of his building to a temperature of 80 deg., in zero weather, the building being exposed on all sides.

The heat loss will be as follows:

Windows $24 \times 14 \times 8 = 2688$ sq. ft.

Walls $(110 + 110 + 130 + 130) \times 11.5 - 2688 = 2832$ sq. ft.

Roof $110 \times 130 = 14{,}300$ sq. ft.

Floor $110 \times 130 = 14{,}300$ sq. ft.

Air change, cubic contents one change in 2 hr.

$110 \times 130 \times 11.5 \div 2 = 82{,}225$ cu. ft. per hr.

The loss per square foot per hour, assuming 20-in. brick walls, single windows and good floor and roof, will be:

Walls 18.2 × 2832	51,542	B.t.u. loss
Windows 88 × 2688	236,544	"
Floor 16 × 14,300	228,800	"
Roof 21.6 × 14,300	308,880	"
Air change 1.64 × 82,225	134,849	"
Total loss	960,615	B.t.u.

per hour for heating only. The factor of exposure is $1.1 \times 960{,}615 = 1{,}056{,}676$ B.t.u. loss per hour. If heated with pipe coils the efficiency of the coils will be about 1.8 B.t.u. per square foot per degree difference in temperature between the steam and room. Steam at 10 lb. pressure has a temperature of 240 deg. $(240 - 80) \times 1.8 = 288$ B.t.u. per sq. ft. of radiation. $\frac{1{,}056{,}676}{288} =$ 3676 sq. ft. radiation required to heat the building. Two-in. pipe has an outside diameter of 2.37 in. and an area of 0.62 sq. ft. per foot of length. $\frac{3676}{0.62} = 5929$ lineal feet of 2-in. pipe required to heat the floor to 80 deg. in zero weather.

As zero weather extends over only about 3 per cent of the entire heating season, and about 75 per cent of the season the amount of radiation required would be about ½ that at zero weather, with a pressure of 60 lb. in the main reduced to 10 lb. at the fourth story it would be better to install less radiation, and carry a pressure higher than 10 lb. in extremely cold weather if necessary. This would reduce the amount of radiation required.

The size of main steam line required to supply this floor with steam when carrying steam at 60 lb. pressure and reduced to 10 lb. at the radiator is:

The total B.t.u. required is 1,056,676 and allowing a loss of 10 per cent is 1,162,344 B.t.u. Each pound of steam liberates $1175.4 + 32 - 80 = 1127+$ B.t.u. and $\frac{1{,}162{,}344}{1127 \times 60} = 17.2$ lb. of steam per min. Steam at 60 lb. gage pressure has a volume of 5.71 cu. ft. per lb., and assuming a velocity of 6000 ft. per min., we have $\frac{17.2 \times 5.71 \times 144}{6000} = 2.36$ sq. in., area of pipe required to supply this floor, which corresponds to a diameter of over 1½-in. pipe and less than 2-in. pipe. Therefore a 2-in. pipe would allow a lower velocity, and would be the proper size to use to supply this floor only.

J. C. HAWKINS.

Relation Between the Travel of Crankpin and Piston

IN ANSWER to J. E. K.'s request for engineers' ideas as regards his crosshead and crankpin problems, I submit the following illustration, in which it will be seen that the connecting rod line AC is longer than AB. By laying off AC on the line AB, it will be seen that AC equals AB + BE. The crosshead moves from H to H′ during half a revolution or single stroke, it moves from H to A in first ¼ revolution and moves from A to

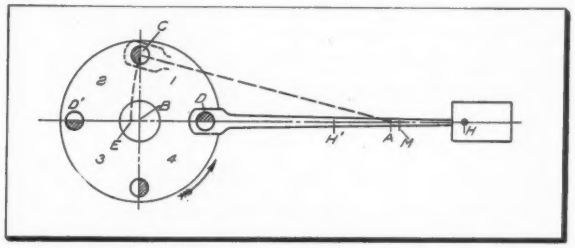


DIAGRAM ILLUSTRATING EFFECT OF ANGULARITY OF CONNECTING ROD

H′ during second quarter of revolution caused by angularity of rod. M indicates exact half stroke and crosshead pin travels farther, taking crosshead with it, during the first quarter than during the second. On the return stroke the crosshead travel during the third quarter revolution corresponds to that of the second, and the fourth with the first.

J. F. POTTS.

ON SATURDAY EVENING, March 7, the Westinghouse interests in the Pittsburgh district held their Fourth Annual Banquet at the Fort Pitt Hotel, Pittsburgh, under the auspices of the Westinghouse Club. Approximately 500 men were present, and spent the evening listening to speeches and entertainment provided by the Westinghouse Club. W. A. Bole acted as Toastmaster, and speakers were A. L. Humphrey, of the Westinghouse Air Brake Co., H. G. Prout, of the Union Switch & Signal Co., C. A. Terry, Westinghouse Electric & Mfg. Co., Guy E. Tripp, Chairman of the Board of Directors of the Electric Co. Other interests represented were the Westinghouse Air Brake Co., R. D. Nuttall Co., and the Pittsburgh Meter Co.

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What Next?

In the article on Progress and Practice in this issue will be found some suggestions as to the line of progress in power plant efficiency which are worth careful thinking about. Whatever may be our opinions as to rate making policies of central stations, it is certain that their engineering organizations are alert for every means by which every possible elusive heat unit may be coerced or cajoled into becoming an electrical unit on the bus bars, for of such are income and profits made. More attention to boiler room conditions has been preached for years, and now is developing into standard practice; flow meters, draft gages, gas analysis instruments and thermometers are becoming as common as engine indicators in up-to-date plants. Boiler loads of 150 per cent rating are common, but 300 to 500 per cent, now being advocated, are yet unusual enough to cause an exclamation, and a 13,000-hp. boiler, forced to 250 per cent, means 32,500 boiler hp., now contemplated in a single unit. Some size to that.

And at the other end comes a proposed refinement in condenser practice to give practically instantaneous condensation of exhaust steam, giving a back pressure of a quarter of a pound or so absolute at the exhaust. A pound pressure doesn't seem much, but if we get rid of ¾ of it, it means a saving of one-sixth in the coal burned. That's worth having.

Central station methods and economies may not apply in every plant, but these suggestions of the ablest thinkers and workers in the power plant field point the path by which economy is to be reached, and the individual plant man may well watch the engineering policy as well as the financial policy of the central station if he would be in position to meet its competition.

Fire Danger

In a modern building, fire is quite as likely to start in the engine room as elsewhere, and a motor or switch may cause a blaze at any point. Fireproof or slow burning construction will prevent fire spread, but sufficient rubbish or other burnable material may, as has frequently happened, neutralize the best of building construction and cause loss and fatalities.

Knowing these possibilities, it is the duty of every engineer, as a man as well as an engineer, to see to it that fire hazards do not exist at any point over which he has control. It is easy to let oily rags or waste be tucked away in corners. Paper and boxes have a natural affinity for passageways, and a switch or starting box is a perfectly enticing place to tuck a magazine or paper behind the wires for safe keeping. But these things burn. And in nearly every city has been a more or less recent "big fire" started by just such little neglects.

Is your plant kept as free from fire hazard at all points as you can make it?

Long Distance Hot Water Heating

Control of temperature in hot water heating is ideal, for a gentle warmth may temper the chill of Spring and Fall, or a vigorous heat may combat the blasts of winter. For large buildings it has generally been considered that steam must be used on account of the pressure needed

for rapid circulation. Recent installations, however, are turning to forced hot water circulation, the water being heated in the boiler room by exhaust or live steam or a combination.

If condensed steam is to be used for boiler feed, it is desirable to avoid sending it through the heating system, because of the liability to pick up impurities, the cooling down in the returns and the amount of water carried in a large system. Water may be used in the heating system which would not serve for boiler feed. Control of temperature at the engine room avoids over and underheating at the whim of occupants of rooms, and disputes as to whether a radiator shall be on or off.

There is one query which seems worthy of an answer by those who advocate this system. What is to be done if a serious leak occurs in a main flow pipe? Draining such a system in a big plant, in order to repack a flange joint, seems like a serious undertaking. The pressure is low, and probably the likelihood of such a leak is not imminent, but it might happen, and what then?

Progress and Practice

Boiler Room Management in Large Central Stations: Standby Provision, and Condenser Improvements

At the meeting of the Chicago Group of the A. S. M. E. on Mar. 18, the general subject for discussion was the Modern Central Station, and inner workings of some of the biggest plants in the country were revealed by the men in charge of them. The meeting was presided over, in the absence of Chairman Bird, by W. B. Jackson, who introduced first I. E. Moultrop of the Boston Edison Co.

Mr. Moultrop spoke of the beginnings of the local meetings and their value to the members and advocated joint meetings with local groups of national electrical and civil engineering societies and with local societies. He suggested that for a local meeting, the best paper is one which arouses discussion and gets many members to talking, even though it may not be of great permanent scientific or engineering value.

The question has been asked why effort is needed to secure new members, and in answer Mr. Moultrop stated that to give engineers their rightful standing in the community they must make a strong showing in their societies. Other national societies have been showing remarkable growth in membership because of concerted effort, and it is necessary for the mechanical engineers to do likewise in order to keep pace with the increased importance of the engineering profession.

Turning to the topic of the evening, Mr. Moultrop stated that the boiler room is now the chief end of the plant, for there lies the chance to show great gains in economy by the use of operating brains. In the past there have been in the electrical end of the plant complete outfits of instruments to show what the plant was doing, but it is only recently that the boiler room has had more than the steam and water gages.

The first assistance in the boiler room was the visual load indicator, to give the fireman an idea of what steam demand he had to meet; and then followed the CO_2 recorder, which Mr. Moultrop thought is better fitted for the laboratory than for the boiler room, since it requires care to keep it operating satisfactorily, and a sample of gas from one part of the uptake may show quite different test from that in another part.

Last have come the flow meter and draft gage for regulating the boiler action according to demands, with feed water regulator and other automatic devices to assist in systematic control. Flexibility of operation becomes imperative with wide variation of load, and ideas of draft control are changing. While a high chimney is ordinarily necessary to carry the gases above the point of being obnoxious to neighbors, and often gives all the draft needed, at least for usual loads, it is an inflexible method and control of draft is needed. This forces the use of mechanical draft, and removes the objection which otherwise might be made to the use of stokers requiring forced draft. Natural draft may be used most of the time, with forced draft during peak loads. In the L St. station in Boston, Murphy stokers are used with ash pits made tight, and the steam jet blowing into the ash hoppers. During regular use, this works the boilers at 100 to 150 per cent of rating, and with the jet blowers, they run up to 300 per cent, the change from 125 per cent to 300 per cent operation being made in 5 min. by this method.

High economy of turbines and electrical apparatus is controlled largely by the designer in choosing the details and types of machinery, the sizes and the conditions under which they are to operate; but in the fire room, the designer has little control of the economy as it is largely an operating problem, and as some 70 per cent of the expense of putting electrical energy on the bus bars is incurred in the boiler room, it pays to pay high wages there, and get high grade men. Use machinery to do away with the manual labor; keep the room clean; provide apparatus to tell what the boiler is doing and thus make the job attractive to young men as an engineering problem.

J. W. Parker, of the Detroit Edison Co., was next introduced and told, as he said, "power plant gossip" about the working of the plant of which he has had charge at the Delray station, equipped with 2300-hp. boilers. He stated that these big boiler units were found more reliable than a big turbine, and that they have never had a unit down when it was needed nor a tube burst. The water is not bad, and they have run 500-hp. units in other plants for 12 to 18 months without opening the boiler, and then found only 1/16 in. scale on the front tubes and headers. This much scale is not serious at 175 per cent rating in 500-hp. units, but with double end boilers, the radiation is toward the first pass tubes and at 200 per cent rating, these tubes are working up to the limit and 1/16 in. scale is too much for satisfactory conditions. No serious trouble has been experienced, but when the boilers are cut out, a bag about the

size of a quarter dollar has sometimes been found in a front tube. It is proposed to use distilled water for makeup, evaporating the water under vacuum, and cooling it by the feed water which comes from the hot well on the way to the boilers, thus putting the heat back into the system. If pitting results from the distilled water, some lime may be used to give a skin scale and prevent corrosion.

By adopting large units in plants, we can afford more instruments, better men and closer attention to efficient conditions. In a new plant now under consideration 120,000 kw. capacity will be installed with 12 boilers, 10,000 kw. per boiler and no spares allowed for, although breechings and uptakes will be installed to care for 250 per cent rating with forced draft, so that a boiler can be taken off for cleaning or repairs and other units carry the load. At the Delray plant, the boilers have performed so much better than was expected that there are really too many boilers. They are operated a good part of the day at low rating because the efficiency is slightly better so that no change is made in the units in service from 5 a. m. to midnight, the operation running from 80 per cent to 200 per cent of rating according to the demand on the station.

It is most important to study conditions and equipment so as to keep load as nearly as possible up to rated capacity. Few realize the bad effect on plant cost of a low load factor, such as is encountered particularly in the fall on purely lighting load.

Mr. Parker endorsed the CO_2 recorded as being most valuable. It runs steadily, gives reliable records and the firemen trust it in regulating operation. Samples are taken from 4 corners of the uptake and mixed in drawing to the machine, so that an average sample is obtained. The record dial with other instruments and control valves are placed together in front of the boiler, giving the equivalent of a boiler switchboard panel. While the flame at the top of the first pass is watched, and gives an indication of the condition of combustion,—a slight haze shows some secondary combustion and a little heavier may be incomplete combustion,—the flame may look clear, but the CO_2 be low due to too much air; and here the recorder checks the action. The percentage of CO_2 runs from 10 at noon or during low load up to 13.5 for average and 16 per cent at 230 per cent of boiler rating, and when these high values are checked by an Orsat test, only a trace of CO is found.

Operation of the large units was found somewhat clumsy at first as the dampers are controlled by the water tender on the gallery and the stokers by an engine; but the effort has been to bring control all under the hand of the fireman at one point, and damper levers, stoker and blower valves are now near the "boiler switchboard." The stoker feed is controlled by a direct current variable speed motor with field control and 18 points on the regulator box. In the new plant, similar motor control will also be used on the blower fans. Hand control has been most effective while learning how to operate the big units, but later automatic control may be devised and found effective.

Two boilers of 2300 rated horsepower each are handled by one fireman, paid 40 cents an hour, with a head fireman to give assistance and relieve temporarily to 9 units. The men have been in service 2 yr., and it is not considered that the high limit of pay has yet been reached. Manual labor in the boiler room should be reduced to a minimum and such as is unavoidable done by helpers, leaving the control of operation as a job requiring brain workers, which will attract trained men and give them the best kind of experience.

John Hunter of the Union Electric Light and Power Co. of St. Louis, was next called upon and spoke first of the origin of local A. S. M. E. meetings through action of the St. Louis Group, then of the electric central station practice in St. Louis, where 60,000 hp. transmitted 145 miles from Keokuk hydroelectric plant at 110,000 volts over 2 steel tower lines is stepped down to 13,200 volts outside the city, 30,000 hp. being delivered to the street railways company, and 30,000 hp. to the lighting company. The lighting company's energy is carried underground at this voltage, a distance of 7 miles, to a substation adjacent to the main steam generating plant, where it is stepped down to the steam generating voltage of 6600. In the steam station we have 3 distinct systems of service; the street railways 25-cycle, the Union Co.'s direct current service from motor-generators for industrial power and business section lighting, and 60-cycle service for residence lighting. The water power energy is connected directly to the bus bars of the steam generators, the 2 systems floating together in parallel.

Service from Keokuk was started on July 1, 1913, and service has been most satisfactory, only 1 or 2 short interruptions having occurred during that time. But, our company decided that to maintain continuity of service it was necessary to keep the steam station as a standby to pick up the load in the shortest possible time.

The floating prime mover is an easy method of operation; but, the condition is much different in the boiler room. We found that it would take 130 lb. of coal an hour to bank the fires in the boilers which would hold them at about 60 lb. steam pressure, with our slow moving chain grates it would take about 30 min. to bring the boilers in on the header with the fires in condition to maintain the desired capacity. As a scheme whereby the boilers could be brought quickly into service and with a less cost, we developed a unique system of keeping the water hot in the reserve boilers with fires set on the grates ready to ignite at a moment's notice.

We placed a tank with a steam coil in the basement directly below the battery of standby boilers, connecting the blowoff headers from these boilers to the bottom of the tank, which supplied the colder water, and connecting from the top of the tank to the superheater connections in the steam drums; the difference in the elevation of these 2 connections in the boilers caused an easy circulation. The steam coil in the tank was connected to a drain of one of the main steam headers of the standby boilers, which were kept alive for emergency service. The steam from these headers not only keeps the system free from water, but also maintains the water for the boilers at a temperature of about 212 deg., taking the heat equivalent of about 12½ lb. of coal an hour, and the boilers can be cut into service and maintain their capacity in about 15 min.

Keeping the fires set for lighting on the grates has solved the question of quick ignition and works out well. The grates are 10 ft. wide by 10 ft. long, on which

we have laid, equally spaced, 2 rolls of oily rags, crosswise and lengthwise, covering the remainder of the grate with a high grade washed nut coal about 1½ in. in size to a thickness of 9 in.; on top of the coal we have kindling wood soaked in oil. These fires may stand any length of time without deterioration or cost, and on ignition burst into flames, giving very rapid generation of steam.

The principal point to be watched in connection with maintaining hot water in standby boilers is to insure that the dampers are kept perfectly tight so there is no circulation of air in the boiler. In this way the brick setting is kept hot and we find that the fire brick suffers very little from the heavy action of the flames when the fires are started.

There is one complication, however, which has arisen in connection with maintaining hot water in the standby boilers during our past 6 months' experience; we find that a pitting action has taken place in the drums of the boilers. This, while not serious, serves to warn us of the danger that confronts us should the action continue. Most of this pitting is in the vicinity of the water line and quite evidently is the result of galvanic action between the metal of the boiler drums proper and particles of carbonaceous matter adhering thereto. The immediate prevention of further action was accomplished by thoroughly cleaning out the corroded spots, scraping and wire-brushing the entire inside of the drums and applying 2 coats of graphite paint, permitting each coat to dry thoroughly.

The method we have adopted to prevent the possibility of further action of this sort, is to change the method of treatment of boiler water. Our plant in St. Louis is on the banks of the Mississippi River, which contains a high percentage of silt, sand and organic matter. We clarify this water for our boiler purposes with a coagulant of lime and sulphate of iron, adding a small percentage of soda ash, which relieves it of its permanent hardness. The use of this soda ash results in the concentration of sodium sulphate in the boilers, and as this is strongly alkaline, it was our opinion that it served as an electrolyte for the galvanic action taking place between the particles of carbon and the iron.

We are just now beginning to use barium hydrate instead of soda ash by which I hope to remove all of the organic matter and a large portion of the sulphate, or permanent hardness, from the water before it enters the boiler, at the same time avoiding the presence of alkaline solution in the boilers. It may be of interest for you to know that before we clarified our own water we were paying to the city for boiler water and other water used in the station over $3000 a month; our own clarifying system costs, on an average, about $150 a month.

We have been having an experience with the cooling coils in the high-tension transformers in connection with our hydroelectric system. These coils are iron, and although this is alternating current, we found that the coils were in a strong magnetic field and were highly magnetized. After being in service for 6 months the inside of the coils has deteriorated rapidly, giving the appearance of galvanic action, and the pipes have become heavily coated on the inside with mud, which has been deposited from the water flowing through them. The deterioration in these coils and the accumulation of mud has forced us to change the coils from iron to brass, and we find there is no accumulation of any kind in the brass coils.

As to the effect of water-power operation on the coal supply on the St. Louis market generally, a year ago at Ashley Street Station we were burning something over 1100 tons of coal a day; we are now burning only half that amount. This falling off in coal consumption by our company and a like amount by the street railways company, caused a large amount of screenings to be thrown on the market, which lowered the prices of all screenings shipped from the mines in this vicinity.

Previous to receiving water power, the peak load in our Ashley Street Plant was 55,000 kw., which required a crew of 122 men for operation only, including coal and ash-handling. The steam generated peak this winter in addition to the water power received was 34,400 kw. The operating crew for this load and for emergency service, should water power fail and the station be required to pick up the entire load, is 87 men. This crew could carry the load for 5 or 6 hr. until extra help is placed in the station, if the interruption extended over any great length of time.

As showing the development in electrical generators and their prime movers in the past 40 yr. In 1885 I served in the engine room in a steam ship on the North Atlantic carrying 10 lb. pressure on low-pressure engines. At one time on a voyage we had trouble with a boiler and actually applied a wooden patch which carried us through to port, and I have seen the ship making 10 miles an hour with no steam pressure showing on the gage. Continuing in the service, as the art advanced I saw the change to cross-compound engines with boilers carrying 85 lb. of steam, to the triple-expansion engine 175 lb. steam; and again to the 6-cylinder quadruple-expansion engines with boilers carrying 200 lb. steam.

On coming ashore in 1905, the steam turbine was in its infancy. In 1903, my company had installed its first turbines, 2 500-kw. and 2 2000-kw., the water rate of these units being about 24 lb. In 1905, we installed 4 5000-kw. units with a water rate of 20½ lb., and in 1909, through the demand for more energy, we decided to change the 4 5000-kw. units for 12,000-kw. with a water rate of 15½ lb., and I have now before me a proposition for a 20,000-kw. horizontal turbine with a water rate of 12 lb.

One of the many points worked out to meet our own conditions, was the condensers originally installed for the 5000-kw. units, which with their auxiliaries afterwards served the 12,000-kw. turbines. The cooling surface on the old units was 4 sq. ft. per kilowatt, while on the new installations this was brought to 1.6, to 1. With cooling water at 86 deg. it is possible to hold a vacuum of 28 in.

With the old condensers and larger load we found a serious congestion in the upper bank of tubes. To relieve this congestion and trouble with packing leaks, caused by the vibration of the tubes through the high velocity of steam, we were forced to open up the top and center banks, taking out 3 rows of tubes in 3 places on both banks, permitting the steam to be carried well down into the condenser and materially relieving the high

velocities, giving a much closer balance in pressure between the top and bottom of the condenser, at the same time removing all trouble in the packing at the tube ends.

In connection with the steam end of our 12,000-kw. turbines, a weakness developed in the third stage diaphragm nozzles, which in my opinion was brought about by the unequal expansion in the diaphragms; this caused the thin nozzle plates to crack and in some cases to break out. This was overcome by change in the design, the nozzles being cast of brass in sectional plates, which, being portable, can be removed without dismantling the machine. Although I do not anticipate that with this new design it will ever be necessary to remove these sections. Outside of this weakness, the operation of these turbines has been most satisfactory, and the maintenance cost practically nil.

Mr. Hunter endorsed the giving of great attention to the boiler room, as 85 per cent of the cost of electrical energy on the bus bars is incurred in the boiler room.

Mr. Parker, answering a question as to barium hydrate for water treatment, said that at Detroit it is used as a makeshift. The use of a compound containing soda ash resulted in foaming, and carrying over of water to the superheaters. The hydrate is fed the same as a compound, and resulted in a fine precipitate which could not be filtered out. Aluminum sulphate is now being tried as a coagulant to gather this precipitate so that it can be filtered.

W. L. Abbot of the Commonwealth-Edison Co. of Chicago spoke jokingly of the remarks of other speakers, and stated that at present current is placed on the bus bars of his company for half the fuel cost of 20 yr. ago, when the Harrison St. station was a world's model.

He dwelt on the possibilities in future reduction of costs, advocating the increase of boiler plant efficiency by using forced draft instead of taking 20 per cent of the heat in furnace gases to give natural draft, reducing the boiler surface and forcing its activity to 500 per cent of present nominal rating, and using increased economizer surface to bring the final temperature of gases down to the lowest point for economy, putting it, perhaps, into 2 stages, and having water enter the first stage at 200 deg. and leave the last at boiler temperature. He saw in this method a possible saving of 20 per cent.

Mr. Abbot spoke of the low efficiency of heat conversion in steam prime movers, 20 per cent being good for the best turbines. The efficiency depends on high initial pressure and low exhaust pressure, and the possibilities in higher initial pressures are small because of high costs. Exhaust is at 1 to 2 lb. absolute pressure and, though this looks small, yet there is a loss of 50 to 75 deg. of temperature range there, a waste for which there is no excuse. His opinion was that there has been less horse sense used in the design of condensers than in any other part of the plant. Steam is passed up and down over tubes at high velocity through narrow spaces, following the practice in high-pressure apparatus, and piling up back pressure, which the high-grade man, advocated in the boiler room, has no means of preventing.

He would have the greatest possible area for steam to strike the condenser tubes as soon as it leaves the exhaust from the prime mover, making all surface immediately available for condensing steam which would pass to this surface at low velocity and with no pressure loss. By this means a gain of 1.5 in. of vacuum could be secured at the exhaust from the turbine with increased efficiency of 25 per cent.

Total cost of energy on the bus bars is about twice the operating cost, due to charges on building and plant. Added cost of power house due to architectural features means an added cost for power to the company and the community for all time. To get low cost requires big units, such as are used at Detroit; and though reasonable protection against interruption is necessary, standby provision for every imaginable contingency runs up overhead charges unreasonably.

Owing to the peak load requirements, about ¼ the capacity of a central station is used only 2 to 3 per cent of the time during the year, so that if the last ¼ of capacity could be omitted, it would increase the plant efficiency some 12.5 per cent. How can this peak be taken care of? Storage battery equipment will cost twice as much as the machinery omitted; so Mr. Abbot suggested windmills or water power in fun, and proceeded to outline a proposition for a shaft a mile deep with a foot tunnel a mile long and 12 ft. diam., having vertical water turbines mounted at intervals of 2000 ft. down the shaft to develop 20,000 kw. for 3 hr. and running the tail water into the tunnel. He estimated the cost of the installation at $400,000 as against $1,200,000 for the steam plant replaced.

But he had not been able to work out the detail of how to empty the foot tunnel. He left that to the engineer who designed the plant.

In a discussion before the American Society of Mechanical Engineers, A. A. Straub called attention to the effect of even a thin scale in boilers where mud is present. He showed a piece of a 4-in. No. 10 gage, lap-welded charcoal iron tube, from the lower row in a water tube boiler, where the combustion chamber was small, and 1/16 in. of scale formed a leak directly under a deposit of mud. The boilers were usually operated at 75 per cent above rating, but the scale was too thin to have had any effect, had it not been for the mud deposited. This was formed from Allegheny River water, containing from 6 to 10 parts per 100,000 of encrusting solids, and treated with enough barium hydrate to neutralize the sulphate content. With such water, cast iron is bound to be eaten out in from 2 to 6 months, and if water is treated as it enters the boiler without a softener, a very slight concentration of sodium salts will cause violent foaming, and make it difficult to keep any water in the front tubes of the boiler.

Mr. Straub also spoke of the case of an arch over a Roney stoker, which was 6 ft. 4 in. long with 11-ft. span and a spring of 16 in. The furnace temperatures were found by pyrometer to be from 2800 to 3000 deg. F. and the arch, which was put into service on Dec. 12, 1910, began to sag and was in bad condition by April 18, 1911, was operated until April 23, when it fell apart and was patched up, and came down entirely on June 25. The short life was due to foamy side walls, and when the arches and side walls were properly rebuilt, they held from Aug. 1, 1911, to Oct. 29, 1912.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Rolling-Mill Engine

REVERSING AND CUTOFF CONTROLLED BY A SINGLE LEVER

FOR this design of reversing engines for rolling mills, results are shown from tests of a 46 and 76 by 60-in., twin tandem, compound reversing engine, built by the Mesta Machine Co., of Pittsburgh, for the Youngstown Sheet & Tube Co.

There is only one controlling lever, A, and this lever operates the relay valve which, in turn, controls both the reversing links and throttle. When the main reversing lever is in position 1 or 2, the throttle is wide open; in position 3 it is closed. The pressure of steam and the cutoff with which the engine works are, therefore, interconnected so that at light loads and medium heavy loads the operator is compelled to work with a combination or throttle and cutoff control. That cutoff is attained with the single-lever control, as shown by indicator cards, Fig. 2, taken during the test.

The opening of the throttle is not simultaneous with the movement of the reversing lever from point 3, for there is a certain idle stroke of the throttle valve. When the throttle opens, steam is admitted through auxiliary ports in the bushings of the main piston valves. This combination of idle throttle valve travel and auxiliary ports makes possible smooth and certain starting in any position of the cranks. These auxiliary ports, of course, admit steam during the regular operation of the engine; that is to say, during the rolling process. But while they are large enough for quick starting, they are too small to affect the shape of the regulator indicator cards or the steam consumption of the engine.

Satisfactory action of the engine depends upon careful proportioning of the throw of the eccentrics the

FIG. 1. ROLLING-MILL ENGINE AS INSTALLED

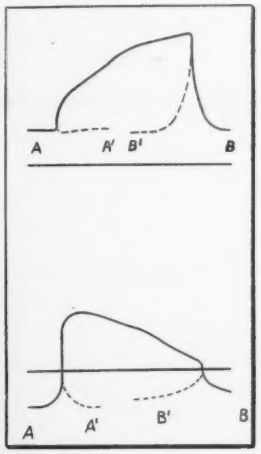


FIG. 2. DIAGRAMS FROM HIGH AND LOW-PRESSURE CYLINDERS, SHOWING CUTOFF EFFECT

length of the links, the size and location of the auxiliary ports and the shape of the steam ports in the bushing of the main throttle valves.

A careful test made by engineers of the Youngstown Sheet & Tube Co., Carnegie Steel Co., Mesta Machine Co., and by professors and students of the Carnegie Institute of Technology, was checked by all of the interested parties so that there could be no possibility of error. The steam consumption of the engine per indicated horsepower-hour was found to be between the limits of 20 and 22 lb., depending somewhat upon the method of rolling, so that 21 lb. may be taken as the average.

In order to make sure that the new method of control would allow sufficiently quick handling of the engine, the time for reversal was repeatedly tested. The average time of change from 60 r.p.m. in one direction to 20 r.p.m. in the other direction was found to be 2.2 sec. Since these speeds are ordinarily found at the end and at the beginning of the passes respectively, 2.2 sec. may be called the mean interval which is required by the engine for reversal. As a rule, the manipulating of the ingot takes a longer period than that required by the engine for reversal.

The results of this test show conclusively that the reversing engine, when correctly designed, need not fear the competition of electric drives, particularly since the remarkable economy has been attained without complication.

Another feature of the installation is that, during the heaviest rolling the vacuum never leaves the range between 27 and 28 in., referred to 30 in. barometer.

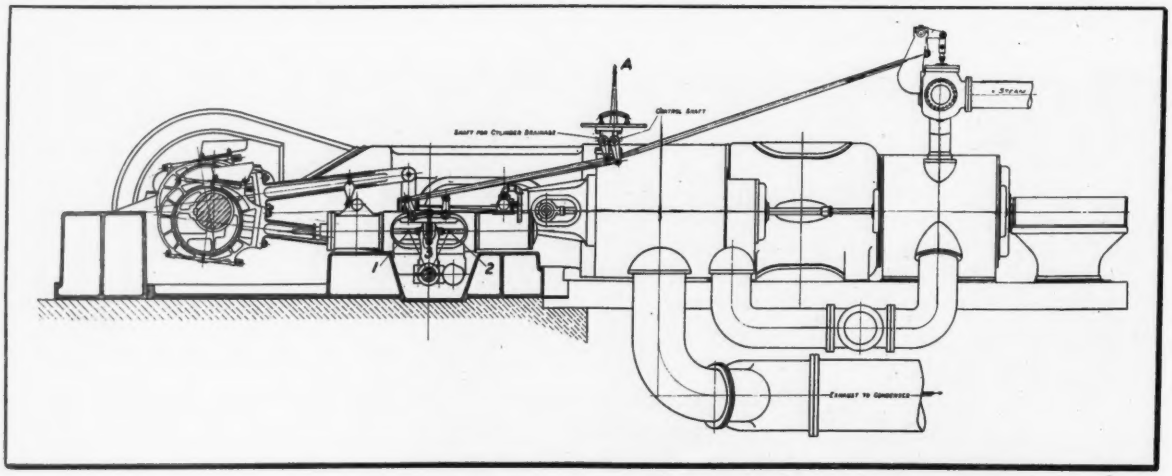


FIG. 3. ELEVATION OF SINGLE-LEVER CONTROL ROLLING-MILL ENGINE

Cutting Out Scale

IT IS evident that to remove deposits of soot, ash and scale, a shearing cut is better than a dig. Yet a shearing action is not easy to get on the inside of a tube. It is secured, however, by the spiral blade of the Chicago boiler tube cleaner, shown in the cut herewith, and other advantages are added by the special design and construction.

The blades are of malleable iron so that they will cut off soot and deposits but will not dig into the harder metal of the tubes. By their spiral shape and raised edges they provide a shearing cut and are sharpened by natural wear, and by mounting on strips of spring steel, held firmly at each end, they are held parallel to the tube walls, exerting a steady pressure outward, but giving way to pass by irregularities or slight contractions.

CHICAGO BOILER TUBE CLEANER

Four sets of blades are provided spaced at 90 deg. and with overlapping ends so no spot on the tube can escape the cleaner's activity. Trial has shown that it is effective, not only cleaning the tubes of return-tubular boilers, but in keeping water-tube boilers in efficient condition. The Chicago cleaner is the product of Seehausen, Wehrs & Co. of Chicago, Ill.

PRESIDENT WILSON'S policy with respect to government control of water powers may be summarized from the newspaper announcement as follows: The Federal Government, under the Constitution, has power to control the building of all water-power projects, but the equities of the states are to be recognized. Federal power affects only the navigable streams of the country. Legislation will be passed authorizing the Secretary of War to issue, at his discretion, permits for the construction of water-power plants, but only to concerns incorporated as public utilities under state laws, thus avoiding discrimination and monopoly. Rentals or tolls are to go to the state. In states where the people are not protected by adequate public utility legislation, permits are to be withheld until laws are passed conforming to the ideas of the federal government on what are proper safeguards. The policy with regard to water power on public lands, contemplates the issue of permits for a period of years under satisfactory arrangements whereby the plants are to come into possession of the national government.

Thwing Pyrometers

THERMO-ELECTRIC radiation and resistance types of pyrometers are manufactured by Thwing Instrument Co., Philadelphia, Pa., in either the indicating or recording form. In selecting a suitable instrument for measuring temperatures under any particular conditions, the temperature range is one of the first considerations. The thermo-electric type will measure temperatures continuously, from about 400 deg. to 2700 deg. F., or for short intervals as high as 2900 deg. F. The electrical resistance type may be used between —325 deg. and 2000 deg. F., but is best adapted for temperatures below 392 deg. F. The radiation type is adapted for use above 900 deg. F., and is the only one of the 3 instruments that can be used continuously above 2700 deg. F.

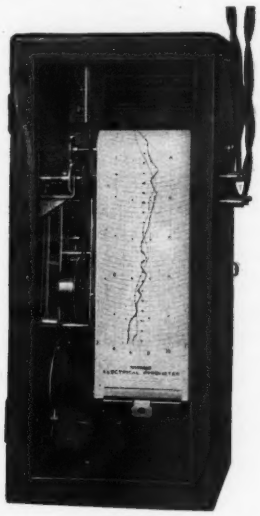


FIG. 2. RECORDER FOR 2 RECORDS ON SAME CHART

FIG. 1. PORTABLE TYPE OF RADIATION PYROMETER

Both rare metal and base metal thermo-couples are used in the thermo-electric pyrometers, the former elements consisting of platinum and platinum rhodium, and the latter of copper, iron, nickel and nickel alloys. The high cost of platinum necessitates the use of very small elements, which, even when protected in the best porcelain tubes, deteriorate after long exposure. This reduces the electromotive force of the thermo-couple, and another error is introduced owing to the varying resistance of the couple when immersed to different depths. These errors have been largely eliminated by the use of elements of less costly material and of larger size, which results in a higher electromotive force of the couple, thus permitting higher resistance in the galvanometer.

For the positive element of such couples, where the temperatures are as high as 2000 deg. F., an alloy of nickel with 6 to 15 per cent chromium, is one of the most suitable, while for the negative element, a nickel alloy with a small percentage of various other substances is used. Where the maximum temperature does not exceed 1650 deg. F., a negative element of about 41 per cent nickel with 59 per cent copper, and a positive element of either chrome-nickel, copper or iron, give both a high and constant electromotive force. This alloy, known as "constantan," has a small coefficient of resistance, and the high electromotive force obtained, makes it well adapted for low temperature measurement.

Since the electromotive forces of the platinum and nickel thermo-couples are but 18 and 60 millivolts, respectively, at their highest ranges, sensitive galvanometers are required. With platinum thermo-couples, the galvanometers used have a resistance of 15 to 20 ohms, and with base metal thermo-couples, when used on full range, a resistance of 75 ohms, making it possible to place the recorder or indicating instruments a long distance from the thermo-couples without introducing any appreciable error due to the resistance of the leads, and rendering unnecessary a recalibration of the instrument for a change in the length of leads.

While amply sensitive, the galvanometer is rugged and powerful, with phosphor bronze control springs and dead-beat needle, which makes the instrument free from disturbances due to vibration. A compensator for room temperature is provided, so that the reading is not affected by variation in the surrounding atmosphere, on account of the change of resistance of the copper wire used in the coil with temperature.

Radiation Pyrometer

With this instrument, the radiations from the source of heat are concentrated by the use of a conical mirror upon the hot junction of a thermo-couple, thus generating an electromotive force which is transmitted by means of copper leads to the galvanometer, as in the thermo-electric type. The mirror and thermo-couple are contained in a receiving tube, or telescope, which may be located at any convenient distance from the source of heat, the only condition being that the surface of the hot body exposed be sufficiently large to fill completely the angle of aperture.

In the portable form, as shown by Fig. 1, the receiving tube is about 30 in. long and a little less than 1 in. in diameter, while in the stationary type, the tube is

made shorter and is kept at a constant temperature by means of a jacket containing water or oil. In most cases it is found desirable to point the telescope at the inner wall of a tube of fireclay or iron which projects into the furnace far enough to take the temperature of the surrounding gases, without admitting cold air to the furnace.

To overcome the difficulty resulting from the settling of smoke and soot on the mirror, the tube is made in 2 sections. The front section contains the diaphragm and the rear section the thermo-couple and its mirror, which may be cleaned by removing the front part and using the conical, felt-covered wiper provided with the instrument. Where it is desired to secure a record of the temperature, and the receiving tube is exposed continuously to heat, a modified form of tube is provided, which prevents disturbing the thermo-couple by the accumulated heat of the tube.

FIG. 3. ARRANGEMENT FOR INDICATING TEMPERATURE AT 4 POINTS

Pyrometers of the radiation type respond quickly to temperature changes, reaching a change of equilibrium within 5 seconds after pointing the tube at the hot body, and returning as quickly to no reading when the radiations are cut off.

In addition to the thermo-electric and radiation pyrometers, is the electrical resistance type, which is suitable for temperatures from about 392 deg. F. down to —325 deg. F., although it may be used for temperatures as high as 2000 deg. F. This, however, is not recommended, on account of greater expense as compared with the thermo-electric type. For temperatures below about 392 deg. F., resistance wire of pure nickel is employed, the coil being enclosed in a tube of varying shape and material, depending upon the conditions under which it may be used. The same bulb may be employed for measuring all temperatures from the transformation point of nickel (about 392 deg. F.) to the lowest temperatures obtainable with liquefied gases.

Recording Instruments

In all 3 types of recorders, the mechanism is almost identical. The record consists of a series of ink marks made by periodically depressing the galvanometer needle upon a chart, which is carried forward by means of a suitably geared, powerful pendulum clock. At frequent intervals, the galvanometer is automatically disconnected from its thermo-couple or resistance bulb, and allowed to return to zero, at which point the needle is depressed upon an ink pad, after which it is ready for making another record. The time occupied may be varied so as to secure 1, 2, or 3 records per minute.

By means of the multiple contact mechanism, 2 or 3 records may be made from as many sources of heat by 1 galvanometer upon a single chart, thus obviating the necessity of using more than 1 instrument. With this device, the galvanometer is automatically switched from one contact to another, thus recording several temperatures upon the same chart. Owing to the different length of ink marks for each record, there is no chance for confusion. The record shown on the chart in Fig. 2, is made by 1 galvanometer attached to 2 thermo-couples, which may be measuring temperatures at 2 widely separated points.

With the 3-record type, a series of contact wheels mounted on the clock is so arranged as to raise and lower a depressing lever and the lower half of 3 contact levers, sending the electromotive force generated by the corresponding thermo-couple to the galvanometer, thus causing the needle to assume the correct position over the graduated chart for the temperature at that heat source. The depressing lever automatically depresses the needle upon the chart, for varying periods of ½, 2 and 4 min., respectively, the time being different for each record. The current is not flowing through the galvanometer throughout the periods, for as soon as the needle is depressed upon the chart, the contact wheel permits the lower half of the contact lever to fall, breaking the circuit so that the temperature recorded is that of the beginning of the period. Where 3 records are made, the complete cycle occupies a space of 7 min., but where only 2 records are made, 3 min. are required, the 4-min. dash being omitted.

With galvanometers of a special design, it is possible to mount several instruments, side by side, in the same case, so that a 10-in. chart may be divided into from 2 to 5 temperature ranges, or where the temperature range is not too wide, and the fluctuations not too frequent, as many as 15 records may be made on a single chart.

Charts are printed on semitransparent paper, which can be readily blueprinted, the graduation being uniformly spaced, as is the case with the scale divisions of the indicating instrument.

Providence Engineering Works, Providence, R. I., has begun the manufacture of Providence Centrifugal pumps, with Albert E. Guy as mechanical engineer in charge of the work.

George Westinghouse

GEORGE WESTINGHOUSE, a conspicuous figure in the world of engineering and inventor of the air brake that bears his name, died of heart disease at his New York City residence March 12, 1914. His health had been failing for some time and consequently his death, although a great shock to his thousands of friends and acquaintances all over the country, was nevertheless in a measure anticipated.

Mr. Westinghouse was born at Central Bridge, N. Y., October 6, 1846, and 10 yr. later moved with his parents to Schenectady. While attending the public schools he spent much time about his father's machine shop and at the age of 15 invented a rotary engine which had many features of considerable merit.

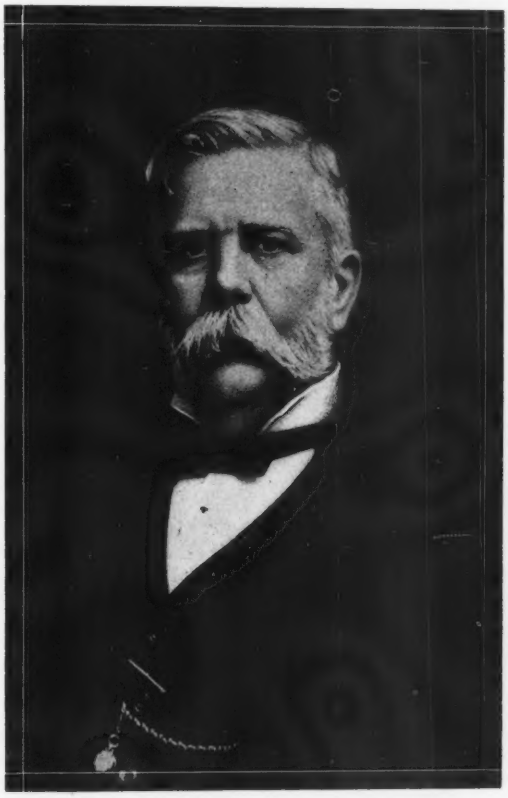
In 1865 he invented a device for replacing derailed railroad cars upon the track, and, while making a trip one day to Troy, N. Y., where the device was manufactured, a delay caused by a collision between 2 freight trains suggested to Mr. Westinghouse the idea that a brake under the control of the engineer, might have prevented the accident. He immediately set about finding a means of stopping trains more quickly and after a few unsuccessful experiments, finally hit upon the use of compressed air. Drawings of the air pump, brake cylinder and valves were then made, but considerable time elapsed before a practical trial of the brake was obtained. The first patent was issued April 13, 1869, and the Westinghouse Air Brake Co. formed on July 20 of the same year, after which the device was further developed by the inventor to its present degree of perfection.

With the air brake stands another great contribution to the world of human industry and which has been one of the foremost factors of modern advancement—the harnessing of the alternating current and the development of apparatus for its application. This led to many legal battles between the interests of Edison and Westinghouse; but, as usual, the latter was able to meet his adversaries at every turn. These are but 2 of the 15,000 or more patents owned by George Westinghouse, his personal inventions alone exceeding 300.

He was one of those rare men who combine wonderful inventive genius with exceptional executive ability. His enterprises, of which there are a score in this country, 3 in Great Britain and others in Canada, Germany, France and Russia, afford employment to approximately 50,000 people and are capitalized at about $200,000,000.

Mr. Westinghouse served in the Civil War with the 16th New York Cavalry until November, 1864, after which he was an assistant engineer in the Navy until the conclusion of hostilities. At the close of the war, resisting solicitations to remain in the Navy, and wishing to continue his college studies, Mr. Westinghouse tendered his resignation and was honorably discharged Aug. 1, 1865. On his return he entered Union College, but, guided by his impulse toward experiment, abandoned his classical studies at the close of his sophomore year to find a wider scope for his inventive genius.

In return for his many achievements in mechanics, electricity, steam, and gas, the highest honors in the gift of the technical societies and institutions of Europe and America were bestowed upon him, European sovereigns conferring distinguished orders. His alma mater, Union College of Schenectady, conferred upon him the degree of Doctor of Philosophy. He was decorated with the order of the Legion of Honor, order of the Royal Crown of Italy, and the order of Leopold of Belgium. He was the second recipient of the John Fritz medal and received the degree of Doctor of Engineering from the Koenigliche Technische Hochschule of Berlin, Germany. He was an honorary member of the American Society of Mechanical Engineers, of which body he was also president in 1910. He was 1 of the 2 honorary members of the American Society for the Advancement of Science and also an honorary member of



the National Electric Light Association of America. He was awarded the Scott premium and medal by the Franklin Institute of the State of Pennsylvania and received the Edison gold medal for meritorious achievements in the alternating current system of distribution. He received the Grashof gold medal from the Society of German Engineers in Germany, which acknowledged him the greatest American engineer.

In his will Mr. Westinghouse provided for the continuation of his large business interests under a trusteeship. It has been announced that his death will not cause any change of policy or operation in connection with any of the industries. A plan which he carefully thought out for their continuance and direction goes into effect at once.

The men chosen to carry out this work are Henry Herman Westinghouse, a brother, who is president of the American Brake Co. and vice president and general

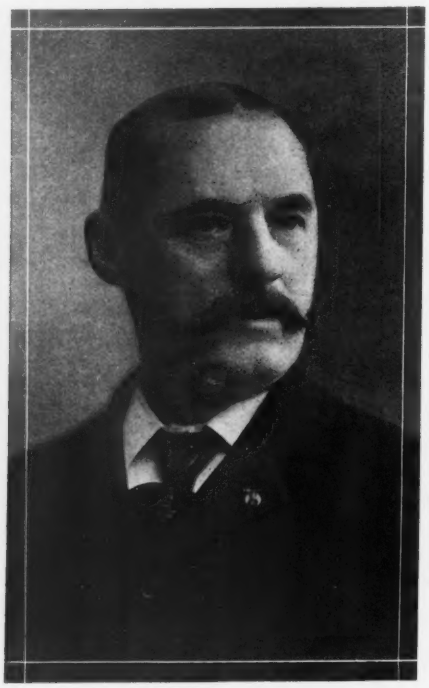
manager of the Westinghouse Air Brake Co.; Charles A. Terry, vice president of the Westinghouse Electric & Mfg. Co., and W. D. Updegraff, director of the Westinghouse Air Brake Co.

To this trusteeship will go the voting power in all the corporations in which Mr. Westinghouse was interested here and abroad. His individual wealth and holdings have been estimated at more than $50,000,000.

Columbus Dill

COLUMBUS DILL was born in Tully, N. Y., August 12, 1840, and died at his home, 99 St. James Ave., Boston, March 4, 1914.

At 12 yr. of age he started in on a seafaring life with his uncle, serving as cabin boy on one of the many trade vessels of the Weld Line, which were at that time plying between Boston and various foreign ports. He rapidly worked up to the position of chief officer, in which capacity he served on such boats as the Rainbow and the William H. Thorndike.



In 1876 he left the sea, and took up stationary engineering as a profession, being employed as an engineer for about a year at the Perkins Institution for the Blind at South Boston, afterwards going with the National Tube Works, then at East Boston, where he served as chief engineer for several years.

He next took a position with John Post, Jr., & Co., of Boston, handling their injector business, after which he became connected with the Common Sense Metallic Packing Co., as a traveling salesman.

In 1889 he accepted a position with the Ashton Valve Co., of Boston, with whom he continued for 25 yr. up to the time of his death. He traveled extensively while in the valve business, going as far west as Kansas City, and south to New Orleans, giving special attention to power plant work, and to the stationary engineers operating them, among whom he had a host of friends and acquaintances.

He was a charter member of N. A. S. E. No. 1 of Boston, and has been elected as delegate for 24 yr. to represent this Association at the National Convention of the N. A. S. E. He had also served as United States Deputy of the N. A. S. E. for 10 yr., which position he held at the time of his death.

He was a member of the E. P. Carpenter Post No. 91, G. A. R., Foxboro, Mass., several Masonic bodies, the Engineer's Blue Room Club of Boston, and the New England Association of Commercial Engineers.

He had not been very active for the past 2 yr., although his health had been fairly good up to within 3 days of his death, when he was taken with an attack of indigestion, which suddenly and wholly unexpectedly terminated with apoplexy. His funeral services were held from his late residence on Mar. 6, at which time there was a large attendance of his engineer friends and business acquaintances.

He leaves a widow, who has been an active worker in the Ladies' Auxiliary of the N. A. S. E. and in the order of the Eastern Star.

Mr. Dill was probably one of the best known travelers among engineers in this country. He was a zealous and untiring worker in business with a kind-hearted and genial disposition, which easily won friends, and an uprightness of character that was beyond reproach.

News Notes

THE TERRY STEAM TURBINE CO. announces the appointment of H. A. Rapelye as sales engineer in the Pittsburgh District, with offices at 2123 Oliver Building, Pittsburgh, Pa.

Mr. Rapelye's broad experience with turbine apparatus in the field of prime movers and auxiliaries qualifies him to take up, in detail, the various phases of turbine application.

H. F. MILLER, WHO for the past year has been associated with the advertising department of the Otis Elevator Co. and for 4 yr. previous to that with the Western Electric Co., has been appointed advertising manager of the Goulds Manufacturing Co., of Seneca Falls, N. Y.

HUMPHRYES MFG. CO., of Mansfield, O., has recently opened an office at 1800 Fisher Bldg., Chicago, Ill., which will be in charge of Mr. Strinskey, and will handle the complete line of pumps and hydro-pneumatic systems manufactured by the company.

THE VALLEY POWER CO., of Elkton, Va., has named H. W. Bertram, of Harrisonburg, as its attorney of record in Virginia. The directors and other officers of the company live in New York and New Jersey. The power company is now engaged in the erection of a 1300-hp. hydro-electric plant on the Shenandoah River near Grove Hill, Page County. It will supply Elkton, Shenandoah City, and Stanley with electric lights and power, and has made an offer to furnish Harrisonburg with additional current. The maximum capital of the company is $100,000. The plant near Grove Hill will cost $50,000 or $60,000.

Catalog Notes

SPRAGUE ELECTRIC WORKS of General Electric Co., New York, has recently issued Catalog No. 329, containing 36 pages on Sprague electric fans.

N. T. C. REGRINDING VALVE booklet was recently published by National Tube Co., Pittsburgh, Pa., and the company will be glad to send copies on request.

PROVIDENCE ENGINEERING WORKS, Providence, R. I., has just issued a bulletin describing some of the essential details of Providence centrifugal pumps.

"NATIONAL" PIPE for Drilling Purposes, is the subject of "National" Bulletin 15A, from National Tube Co., Pittsburgh, Pa. The company will be glad to mail copies of the bulletin to readers at their request.

HOT WATER HEATER catalog, just issued by Frank L. Patterson & Co., 26 Cortlandt St., New York, describes the various types of Patterson hot water heaters and converters.

CINCH Expansion Bolt and Engineering Co., 208 Lafayette St., New York, has issued a 32-page catalog, No. 101, giving advantages of the "Cinch" expansion bolt over other methods of anchorage.

GENERAL CATALOG has just been issued by New York Belting & Packing Co., 91 and 93 Chambers St., New York. It contains 230 pages on mechanical rubber goods and is illustrated with halftone cuts.

DIFFICULT DRILLING AND BORING Made Easy is the title of a new publication from Pawling & Harnischfeger Co., Milwaukee, Wis., describing and illustrating actual work done by the company's drill presses in machine shops.

THE DRILHAMMER is a new tool described in a booklet from Orr & Lockett Hardware Co., 401 Broome St., New York, and 14-16 W. Randolph St., Chicago. This booklet may be of interest to mechanics who have occasion to use a cold chisel or drill and hammer.

PORTABLE OZONATORS, for general ventilating purposes and for counteracting the effect of odors, are described and illustrated in Bulletin No. 49,000, from Sprague Electric Works of General Electric Co., 527 West 34th St., New York.

LATEST CATALOG from The Leavitt Machine Co., Orange, Mass., describes and illustrates the improved Dexter valve-reseating machine, for reseating all flat and taper-seated valves, ¼ to 12 in., without disconnecting the valve from the pipe.

HISTORY, CHARACTERISTICS and the advantages of "National" pipe are discussed in "National" Bulletin No. 11B, from National Tube Co., Pittsburgh, Pa.

A circular from the same company shows, by illustrations from photographs of sections of wrought iron and steel pipe which were removed from the warm-water feed lines of a conservatory, the comparative destruction from corrosion.

CATALOG NO. 132, just received from the American Well Works, of Aurora, Ill., is devoted to standard types of American centrifugal pumps. It is fully illustrated with halftones and sectional drawings, showing a number of installations and performance curves. The book also contains a large amount of data of use to people operating and installing pumping equipment. It may be had on request.

THE LATEST BULLETIN issued by the Lagonda Mfg. Co., on Automatic Cutoff Valves, is an excellent example of the present-day type of engineering catalog, which is looked upon by engineers and plant managers as a text of concise information. This book takes up

the causes and effects of water hammer in boilers, the effect of cutting in boilers below or above the pressure of the steam header, the specifications of boiler insurance companies, and the methods of Government tests.

A copy of this bulletin will be received by writing to The Lagonda Mfg. Co., Springfield, Ohio.

THE NEW LINK-BELT BOOK on Silent Chain Drives is an engineering data book which will enable users of power to select the correct Silent Chain Drives for their work and determine exact costs from list prices shown in the book.

Besides giving complete Engineering Information on Silent Chain Driving in simple and compact form, Data Book No. 125 describes many uses of Silent Chain for the efficient transmission of power and gives specific reasons and illustrations showing application in a large variety of uses.

Link-Belt Silent Chain is a series of links connected by joints which consist of segmental case-hardened bushings and case-hardened steel pins, giving the flexibility of leather belt and positive action of a gear. Its efficiency on actual tests is 98.2 per cent, transmitting any amount of power quietly. Over 200,000 installations, we understand, were drawn upon for the information contained in this data book.

The book consists of 112 pages, bound in flexible red cover, and copies can be obtained free of charge by addressing the manufacturers, Link-Belt Co., 39th St. and Stewart Ave., Chicago.

THE SUPPLYMEN'S ASSOCIATION of the American Boiler Manufacturers' Association, announce the completion of their list of boiler, tank and stack manufacturers of the United States and Canada, which is compiled in neat booklet form and contains names and addresses of over 900 manufacturers. These books are offered to persons interested, such as tool and material manufacturers, for the sum of $3 a copy. Address B. F. Slocum, Sec'y, care of The Continental Iron Works, West and Calyer Sts., Brooklyn, N. Y.

Trade Notes

RANDOLPH-MEANS CO., consulting engineers, Oliver Bldg., Pittsburgh, Pa., report awarding contract with the New River Co., Macdonald, W. Va., to Epping-Carpenter Pump Co., of Pittsburgh, for 15 power and centrifugal pumps for mining service.

THE TERRY STEAM TURBINE CO. announces that it has concluded arrangements with Fraser & Chalmers, Ltd., whose head office is at 3 London Wall Bldgs., London, Eng., whereby their organization will handle Terry turbines in England and Colonies (with exception of Canada).

This arrangement does not include marine forced draft sets which are handled by Yarrow & Co., Ltd., Scotstoun, Glasgow, as heretofore.

AMONG THE CONCERNS placing orders recently for Nelson cast-steel valves with the Nelson Valve Co., Chestnut Hill, Philadelphia, are: New York Edison Co., New York City; Edison Electric Illum. Co., of Brooklyn; East St. Louis Light & Power Co., Alton, Ill.; Rochester Railway & Light Co., Rochester, N. Y.; Erie City Iron Works, Erie, Pa.; Pennsylvania Railroad Co., Cleveland Electric Illum. Co., Cleveland, Ohio; Cleveland Municipal Elec. Lt. Plant, Cleveland, Ohio; Hudson & Manhattan R. R. Co., New York City; General Electric Co.; Westinghouse Electric & Mfg. Co.

IN VIEW OF the questions that have been raised by various correspondents as to the satisfactory action of graphite in steam boilers, the letters received by the Joseph Dixon Crucible Co., of Jersey City, N. J., from 2 engineers, are of interest.

The first is from J. F. Howey, Chief Engineer of Schorsch & Co., of New York City, and states that using Dixon's boiler graphite No. 2, he had "good success removing scale from 2 Dillon horizontal tubular boilers, and it proved to be as good as scale preventive. Am now using it as scale preventive in 2 Heine boilers and it is giving entire satisfaction."

The second letter from Peter Loch, Chief Engineer of the M. H. Shaw Co., of Chicago, which manufactures food products and is, therefore, particular that live steam from the boilers shall be free from all impurities, states that they have used flake boiler graphite for a considerable time, finding it satisfactory in removing scale; that they were skeptical as to the graphite carrying over into the steam, but find it safer than anything they have ever used.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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Position Wanted

POSITION WANTED—As assistant engineer or will fire, wipe or oil in some electric light plant or manufacturer which has electric machinery in connection; can give good reference; strictly sober; am student of I. C. S.; some experience; hold first class license; will accept a small salary to begin with and chances of a raise as I advance. Address Robert Pieper, Route 5, Houston, Minn. 4-1-1

POSITION WANTED—By Electrical and Mechanical Engineer as Superintendent or Chief Engineer of suction gas or oil engine light and power plant. Broad experience. Power plant erection and maintenance. Age 30. Married. Speak Spanish. W. M. Gardner, Shreve, O. 4-1-1

POSITION WANTED—As Engineer in small town. Have had twelve years' steam and electrical experience; also practical machinist. Address Box 339, Practical Engineer. 3-15-1

POSITION WANTED—By Stationary Engineer, 12 years' experience with Corliss and high-speed engines, thoroughly familiar with A.C. and D.C. generators, also with heating and ventilating large buildings. Am at present employed in a large Educational Institution. Can give the best of reference. Married, and strictly temperate. Address Box 340, Practical Engineer. 3-15-2

Wanted

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old-established manufacturer in the power-plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

WANTED—Copies of October 1st, 1913, issue of Practical Engineer. Your subscription will be extended 2 months in exchange for a copy sent to us in good condition. Address Circulation Dept., Practical Engineer.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once, for full particulars. Address Dept. C, Practical Engineer, Chicago.

WANTED—A small ice making plant, with a capacity of 10 to 15-tons, is wanted by a subscriber. Prefers second-hand outfit. Give full particulars. Address Box 341, Practical Engineer. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscription for Practical Engineer. You will be paid well. Write Subscripiton Dept. They will start you in at once.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

Help Wanted

MUST HAVE SALESMEN—Wanted at once, hustlers in every city, to take orders for ZINCO SOOT DESTROYER. Quick, easy seller. Engineers are waiting. Fine proposition. Address New York Supply Exchange, Detroit, Mich. 4-1-2

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

SALESMAN WANTED—Live steam specialty men make from two to five thousand yearly in commissions. Plenty of good territory available. Address Box J, Fostoria, Ohio. 4-1-1

For Sale

USE AND AIR-FRICTION with new 1914 improvements. Increases power and economy of motor one-half. Absolutely impossible to choke or load. Uses distillate, gasoline or half kerosene with finest results. Starts easy in coldest weather. We fit all motors, guaranteeing definite results or refund money. Exclusive county rights. Liberal exchange on other carburetors. The Air-Friction Carburetor Co., Dayton, Ohio. 2-15-6

GROBET SWISS FILES are the standard of excellence in files, and have been for over 100 years. We send post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 4-1-1

FOR SALE—250-VOLT, D.C. UNITS—25-kw. Sturtevant with Sturtevant Marine engine, $550. 30-kw. Ft. Wayne with Skinner engine, $600. Two 75-kw. Crocker-Wheeler with Harrisburg engines, $1200. 150-kw. Western Electric with Watertown engine, $1450. Duzets & Son, 50 Church St., New York. Send for complete "Bargain List." tf.

OUR MODERN BLUE PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

FOR SALE—Two 250-kw. Rotary Converters, type E. C., form E, class 6-250-500, 500 r.p.m., 600 volts, d.c.; d.c. amperes 416; a.c. end, 25 cycles, 3 phase, 360 volts. These machines are in A-1 condition and can be delivered at once. Price, $1,400 each, f.o.b. cars (Penna. delivery). F. H. Herring, Inc., 30 Church St., New York. 2-15-6

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To see that things are right.

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No need to beg us go and buy.
It's us that has to pay the price
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I never read the ads."

And the oil drips down on his floor
On engine bed and pan.
His coal is bought without a test,
The grade the salesman says is best.
And cost records are "foolish frills";
He says, "I buy and pay the bills—
No quibble—like a man."

A little farther down the street
Another chief I know.
Upon his desk, paper and book
Are handy for a spare-time look.
Though plant is big, it's strange to say,
He finds the time most every day
To read a page or so.

His plant is clean. A filter cuts
The oil costs 'way down.
The coal is bought by burning test;
He uses slack, mined in the West.
Repairs are few. Kept records say
Expense grows lower with each day.
A good plant, all around.

The point is here, friend engineer,
This moral I relate.
One draws threefold the other's wage,
He gains it from the printed page.
He saves because he only buys
Equipment that is advertised.
He keeps right up-to-date.